BUILD A CUTTING-EDGE WORKSTATION
Piece together a small but perfectly formed PC **PG. 66**

PERFECT PORTABLE POWERHOUSE?
Dell's XPS 15 is petite but incredibly powerful **PG. 74**

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Why you'll be blown away by the Devialet Phantom Duo **PG. 78**

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- Fix hardware problems
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Z170 ROUND-UP

BEST SKYLAKE MOTHERBOARDS

Pick the perfect board for your next build **PG. 24**

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inside

MAY 2016

38
MAKE WINDOWS 10 AWESOME

24
SKYLAKE MOTHERBOARDS
Get the most from your Intel 6th Gen Core processor with our guide to the best mobos.

38
MAKE WINDOWS 10 AWESOME
Push your system harder with 35 top tips and tricks.

48
OPTIMIZE GAMING GRAPHICS
Discover what all those mysterious graphics settings do and make games gorgeous!

QUICKSTART

12 **THE NEWS**
Apple and FBI in security showdown; Vaio, Fujitsu, and Toshiba may merge PC divisions; VR future of Facebook.

18 **THE LIST**
Eight Vive launch games.

Build yourself an impressively powerful Core i5 machine.

R&D

56 **AUTOPSY**
We go under the skin of the Microsoft Surface Pro 4.

58 **HOW TO**
Build your own PiBot monitor; manage passwords with KeePassX; create a multiple exposure image.

66 **BUILD IT**
Assemble a furiously fast Core i5 PC.

LETTERS

20 **DOCTOR**

94 **COMMENTS**

IN THE LAB

72 **DIGITAL STORM EQUINOX**

80 **ZOTAC NEN STEAM MACHINE SN970**

85 **LOGITECH G810 ORION SPECTRUM**

88 **XCOM 2**

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Tuan
Nguyen

THE ENDLESS PURSUIT

THERE'S A DECREE in the PC-osphere that goes something like: Get the best you can afford, and then push it a little further. Or something like that. This is true for both makers and users.

For manufacturers, there's always going to be the need to differentiate themselves and their wares. This holds most true with motherboard makers. As truly commodity products, there are probably more motherboards available on the market now than hairs on my head. This plays out pretty well in the consumer space as companies race to pack in just about every imaginable feature. We're at a stage now where gold Nichicon capacitors aren't sexy enough—RGB lighting is the new trend. Yeah, really.

Let's distill down to a few notable options, then. The latest releases come in the form of Z170 motherboards, which I think are an evolutionary step forward. Compared to Z97, Z170 motherboards have an additional 12 PCIe lanes, DDR4, PCIe 3.0 support for NVMe storage, and four extra USB 3.0 ports. Everything else is just bells and whistles. If you're going to upgrade, your primary reasons are going to be either the use of multiple GPUs and/or faster storage. Then there's RGB lighting. Hey, the envelope needs to be pushed!

From a user's point of view, sometimes we've simply got to have the very best. And that's a perfectly acceptable reason to upgrade—needs aside. Which brings us to the question of Windows 10. You can't really go out and buy a newer Windows 10. You have to make do with whatever Microsoft decides to give you in its updates. Or do you?

Windows 10 is chock-full of hidden features and options that you can tweak to eke out noticeable performance gains.

By default, Microsoft turns on lots of services and applications that can be disabled, especially if your machine is used primarily for gaming. Services, in particular, take up lots of unnecessary CPU cycles and RAM, so you'll want to immediately turn off some features after a fresh install. There are default Windows applications that you can disable or uninstall if you don't need them. Don't want Cortana always idling? Gone. Don't want Internet Explorer in favor of another browser? Done.

And what about games? Options in games are probably where you're going to see the biggest gains in performance. The caveat is that you'll usually have to sacrifice some quality in graphics. If you've got a monster machine, though, you might not have to worry about that. Depending on the games you play, frame rate will be king. We take you on a tour through virtually every available option and what they all mean in this very issue. MSAA versus FSAA versus CSAA versus TAA? Check.

"I've done all that stuff, and watching turtles race is still faster," you say?

Well, then it might just be time to build yourself a new system.

Tuan Nguyen is Maximum PC*'s editor-in-chief, also known as "the pointy end of the stick." He's been writing, marketing, and raising hell in the tech industry for 19 years.*

↘ submit your questions to: comments@maximumpc.com

THE NEWS

Apple and the FBI in Security Showdown

Who knew that an iPhone could cause such a ruckus?

THE BIGGEST tech story of the year is likely to be Apple's hardline opposition to a court order that it assist the FBI with hacking an iPhone. Not just any iPhone, mind you, but the one that belonged to one of the San Bernardino shooters in a massacre that left 14 people dead and several others injured.

The FBI used a statute that's over two centuries old, called the All Writs Act, to compel a federal court to force Apple to provide "reasonable technical assistance" to bypass certain security measures. Specifically, the FBI wants Apple to update the killer's iPhone with a stripped version of iOS that would allow the agency to guess the handset's passcode using brute-force, without fear of it wiping out the data after 10 failed guesses.

Apple filed a motion to vacate the order, one that will probably be ruled on by the time you read this—though without conclusion as either losing side will no doubt appeal. That's because there's so much at stake here. From Apple's vantage point, it's about user privacy and security.

Apple fears that giving the FBI back-door access to an iPhone that belonged to a suspect would leave millions of smartphones at risk.

"The passcode lock and requirement for manual entry of the passcode are at the heart of the safeguards we have built into iOS. It would be wrong to intentionally weaken our products with a government-ordered back door. If we lose control of our data, we put both our privacy and our safety at risk. Second, the order would set a legal precedent that would expand the powers of the government, and we simply don't know where that would lead us," Apple states in a related FAQ page on its website

Apple sees the creation of a back door, or master key of sorts, as a slippery slope. In its motion to vacate the order, the Cupertino company asks what's to stop the government from taking it a step further, and "demanding that Apple write code to turn on the microphone in aid of government surveillance, activate the video camera, surreptitiously record conversations, or turn on location services to track the phone's user" if it wins the case.

FBI director James Comey downplayed Apple's concerns in an editorial he wrote for Lawfare. He said the issue is actually "quite narrow" and that the relief it seeks is "limited."

"We simply want the chance, with a search warrant, to try to guess the terrorist's passcode without the phone essentially self-destructing, and without it taking a decade to guess correctly. That's it. We don't want to break anyone's encryption or set a master key loose on the land," Comey wrote in his article.

So, which side is right? That depends on who you ask, of course. Republican presidential hopeful Donald Trump is in agreement with the courts. During a rally in South Carolina, Trump told a crowd of supporters that they should boycott Apple until it complies. The public, however, is largely divided on the issue—in a Reuters/Ipsos poll, 46 percent of respondents said they agreed with Apple, and 35 percent said they disagreed.

Apple is getting strong support from other tech giants, such as Microsoft, Google, Facebook, and Twitter, all of which are expected to file pro-Apple amicus briefs.

There's one other long-shot solution on the table—security legend John McAfee has offered to hack the iPhone in question for free, so Apple doesn't have to create a back door. **–PL**

> “Apple sees the creation of a back door, or master key of sorts, as a slippery slope.

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VAIO, TOSHIBA, AND FUJITSU MAY MERGE PC DIVISIONS

Three-headed monster attacks Japan

IT'S BEEN JUST over a year since Sony spun off its Vaio PC brand to a Japanese investment firm, so that it could focus on its mobile business—that seems to be where all the cool kids want to hang out these days. At the time, it wasn't clear what the future would look like for Vaio, though as it turns out, it could be a key part of a three-way deal to create a very large Japanese PC company.

According to Bloomberg, Vaio is close to inking a deal that would bring together the PC divisions of rivals Toshiba and Fujitsu. Vaio would own the biggest stake in the new venture, the result of which would be a rather large PC outfit that would be in position to be the top seller of PCs in Japan.

Hidemi Mouse, CEO of Japan Industrial Partners Inc., the investment firm that bought Vaio from Sony last year, says "there are merits to working together" in a shrinking PC market. The way Mouse sees it, a three-way merger would help all three firms to "make the most of research, production volumes, and marketing channels," and they could do it "with minimal cannibalization."

Not everyone is as optimistic as Mouse. One analyst whom Bloomberg spoke with, Damian Thong at Macquarie Group Ltd. in Tokyo, said the merger mainly makes sense if the companies are looking to "build a niche consumer base in Japan," but that combining the three would "probably have little chance of success" in other countries.

All three firms are in a bit of a rough spot. PC shipments are down, according to recent data by IDC and Gartner, and none of the aforementioned companies is among the top five vendors—Lenovo, HP, Dell, Asus, and Apple fill the list (in that order). **–PL**

By coming together as one, Vaio, Toshiba, and Fujitsu could dominate the Japanese PC market.

ZUCKERBERG SAYS VR IS THE FUTURE OF FACEBOOK

VESTED INTEREST

AT FEBRUARY'S MOBILE WORLD CONGRESS tech show in Barcelona, Samsung launched two new smartphones, along with Gear 360, a camera that can capture 360-degree video and stills. With that, Facebook CEO Mark Zuckerberg made a surprise visit on the stage after Samsung presented attendees with a VR experience using Gear VR. He talked about how social networking VR will arrive sooner than we think, and that VR is the future of Facebook.

"VR is the next platform, where anyone can create and experience anything they want," Zuckerberg told the audience. "Pretty soon, we're going to live in a world where everyone has the power to share and experience whole scenes as if you're just right there in person."

Facebook acquired Oculus VR back in March 2014 for $2 billion, and should have started shipping Oculus Rift headsets to consumers by the time you read this. **–KP**

MICROSOFT BUILDS THEN BURNS ANDROID BRIDGES

Porting solutions nixed

MICROSOFT WANTED TO MAKE IT EASY for mobile app developers to port their software over to Windows 10, without having to rewrite their code, so it created a series of so-called bridges. They're essentially toolkits designed to do the dirty work for developers. There was one for porting Android apps to Windows 10, called Project Astoria, but it's now appropriate to refer to it in the past tense because Microsoft has burned that bridge.

The other bridges Microsoft has built includ one for porting iOS apps over to Windows 10, and another for web apps. There are also plans to build a bridge for Win32 apps sometime this year. Those are unaffected by the announcement, though the iOS bridge may see an uptick in activity.

News of the change comes a day after Microsoft inked an agreement to acquire Xamarin, a cross-platform mobile development software vendor. **–PL**

Tech Tragedies and Triumphs

A monthly snapshot of what's up and down in tech

TRIUMPHS

GONE IN A FLASH
The web can't be rid of Flash content fast enough. Google is helping by banning Flash-based ads by 2017.

KEEP IT QUIET
While we wait for new CPUs, AMD redesigned the stock coolers that ship with some of its own. They're quieter and dissipate more heat.

GAINING GROUND
For the first time, Windows 10 jumped past Windows XP, an OS that refuses to go away, to take the third spot in OS usage.

TRAGEDIES

WRONG REMEDY
Remedy initially recommended a pricey GeForce 980 Ti to play *Quantum Break* but later clarified that it was only needed for Ultra settings—phew!

FBI FAIL
A hacker used social engineering to hack the FBI, making off with details of 29,000 government employees.

CASUALTY OF WAR
A Google engineer who'd left reviews of USB Type-C cables on Amazon ended up sacrificing his Chromebook Pixel to a shoddy cable.

Dave James

TECH TALK

Is Moore's Law Dead?

HISTORICALLY, ONE OF THE FAVORITE games in the PC tech world has been predicting the end of Moore's Law. You'll find stories of its imminent death going right back to 1965, when Intel cofounder Gordon Moore initially formulated his observation. But, one way or another, Moore's Law always finds some way to carry on.

Speaking at the International Solid State Circuits Conference in sunny San Francisco, William Holt has been quoted around the wider web talking about "major transitions" in the field of processor manufacturing, which will see energy efficiency rise, but CPU performance taking a retrograde step.

The comments by Holt, Intel's executive VP and GM of its Technology and Manufacturing Group, have been taken as a tacit acknowledgement that Moore's Law is barely existing on life support right now.

We are, indeed, running into a physical problem when it comes to silicon-based field effect transistors (FETs), and their doubling on a chip biennially. The reason is that, at the current CPU production nodes, energy leakage across the transistor gate is a serious issue. Leaked current wastes power and causes temperatures to rise, and when the insulating layers within a transistor drop below 3nm, leakage rises exponentially.

In Skylake chips and their 14nm Tri-Gate transistors, the insulation layer is reportedly only 0.5nm thick. Switching from flat, planar transistors to three-dimensional versions has helped—most especially in getting down to a stable 22nm FET and beyond—but further shrinkage down to 10nm and then 7nm will probably see the end of silicon as a realistic property for going any smaller. The next two generations of processor and transistor architecture could, then, represent the end for Moore's Law.

After that, Intel needs to shift to newer technologies and materials. Holt mentioned tunnel field effect transistors (TFETs) and spintronics as two of the possible technologies Intel is pursuing. TFETs monitor the phenomenon known as quantum tunneling, where an electron is able to "tunnel" through an energy barrier (the effect that causes the aforementioned leakage), and use its appearance on the other side to discern an on or off state.

Spintronics, meanwhile, use the quantum mechanical spin of electrons to measure its 0s and 1s. It is also closer to commercial production than TFETs, and could appear in the low-power memory systems of our graphics cards in the next few of years. But neither technology is able to keep pace with current silicon-based CPUs in terms of performance.

"The best pure technology improvements we can make will bring improvements in power consumption, but will reduce speed," says Holt. So, does this mean the apparent death of Moore's Law will also mean the death of high-performance computing? Of course not. The likelihood is that whichever technology follows the traditional FET—be it tunneling, spinning, or using materials such as graphene or gallium arsenide—will initially go into products that demand ever greater efficiency, and don't rely on straightline performance, such as simple IoT and mobile devices.

High-performance computing, though, isn't entirely based upon such efficiency concerns, so it will carry on, perhaps using a stalled production node, but iterating upon mature manufacturing processes to continue following at least some tenets of Moore's Law. You may not get double the transistor count but, using older processes, the chip cost could still halve every two years.

Combining the newer technology within hybrid integrated circuits, however, could keep things trucking along the performance curve, too. By using smaller TFETs or spintronics transistors in a chip, in places where energy efficiency is vital and leakage a larger problem than performance, the transistor count could keep on rising.

It's only at the outset of this new dawn of post-FET or post-silicon computing where performance may head in reverse—in time, it will inevitably start heading in the right direction again, and we may well see a rebooted Moore's Law to cover that. So, we're looking less at its death and more at a rebirth.

> Neither tunnel field effect transistors nor spintronics can keep pace with silicon-based CPUs in terms of performance.

Dave James has been building and writing about PCs and their components for the last two decades.

Future

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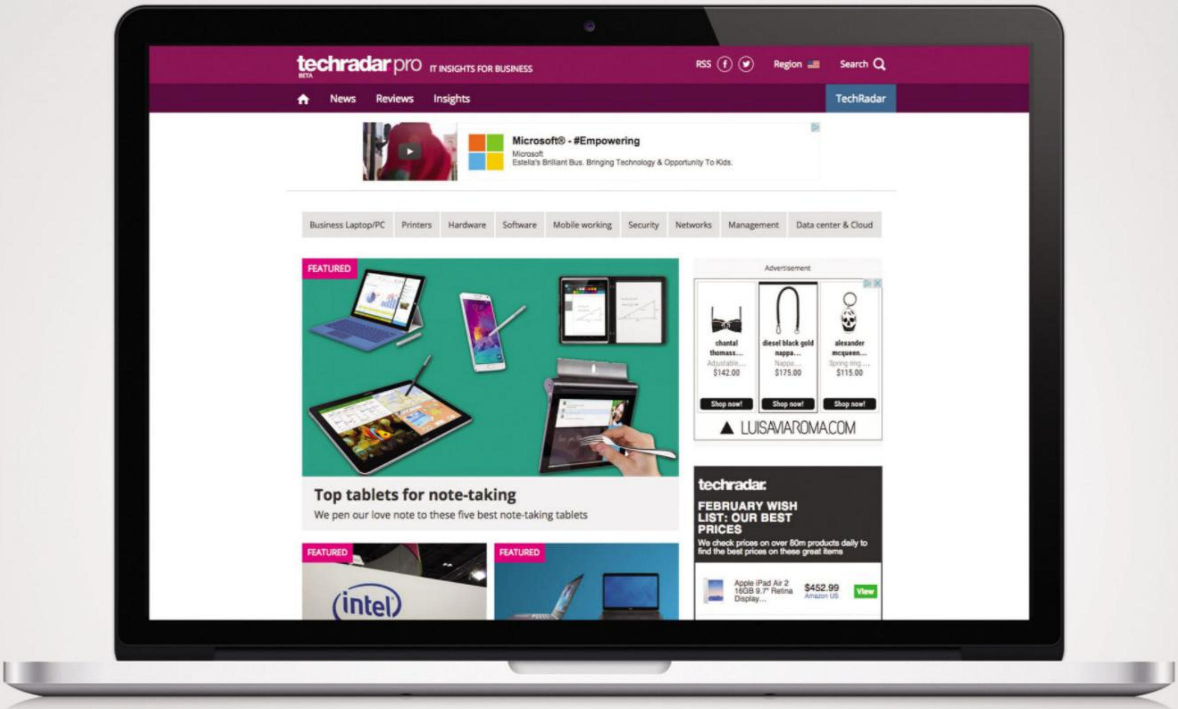
IT INSIGHTS FOR BUSINESS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Alex Campbell

OPEN SOURCE

Dear IRS: Volunteer Computing Should Count

BY THE TIME YOU READ THIS, you will probably have already filed your 2015 tax return. (If you haven't, get on it already!) Taxes are a pointed subject for many, but the fact remains that federal, state, and local taxes pay for the military, police, fire departments, roads, and schools.

It's really tough to imagine modern American life without these services that we take for granted every day.

Even though we all depend on these services, nobody wants to pay more than they owe. If you get a W-2 every January, there's a good chance that Uncle Sam is taking money out of every one of your paychecks. And most of the time, he's taking one-twelfth of an approximation of what he thinks you'll owe at the end of the year. Your tax return is your chance to take back what's yours. And you should get back every red cent you're owed.

There is a bunch of deductions you can take to reduce your tax bill and increase your refund. There's the Standard Deduction, which is a good starting point for many, but some people itemize. One of the things you can deduct is charitable donations to qualified nonprofits.

I donate CPU time to three big projects using the open-source Berkeley Open Infrastructure for Network Computing (or BOINC) program. By leaving my PC on when I go to bed, SETI@Home looks for patterns in radio data that could indicate intelligent alien life; Climateprediction.net creates climate models for scientists; and Rosetta@Home works on protein folding for the University of Washington to look for cures for HIV, Malaria, cancer, and Alzheimer's. I do all of this computation on a rig that has a Core i7-5930K and a GTX 980 Ti, working at about 80 percent load all night. And that gets expensive when the PG&E bill arrives. I wanted to see whether people who donate their hardware to research overnight could deduct the cost of the power needed to run it. From what I found, the short answer is no, while the longer answer is that nobody really knows.

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FOR DISTRIBUTED
COMPUTING
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And he wants YOU to pay for it.

> I wanted to see whether people who donate their hardware to research could deduct the cost of the power needed to run it.

I called the local IRS media office to see whether it had an answer. The IRS sent me a few links, but none of the examples really applied—they all dealt more with monetary donations. Looking for more help, I contacted H&R Block to see whether anyone there could give me a straight answer.

"This is an interesting concept without a perfect precedent for this unusual form of deduction," Gil Charney, director at H&R Block's Tax Institute said. "Although there are powerful arguments on both sides of the question, in the absence of IRS guidance, I wouldn't recommend deducting it even if you could value it."

So, basically, nobody knows where the law stands. But I'm not going to chance it, because I don't want to have to explain power draw, distributed computing, and TDP to an IRS auditor. That's too bad, because by participating in BOINC projects, users are materially donating to research projects. Some of those projects directly benefit the US government. (The NIH leverages Rosetta@Home to find cures for diseases.)

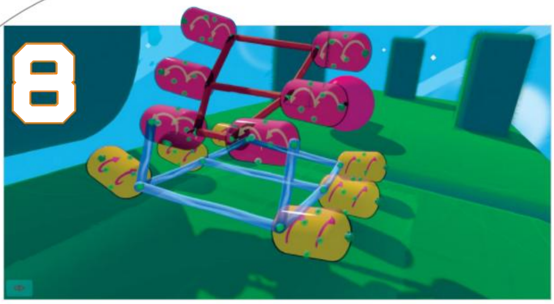
If someone who drives their car while volunteering can deduct 14 cents per mile, BOINC volunteers should be able to reclaim some of the electricity costs that they incur on behalf of their government. This is something that the folks at the IRS should consider and issue guidance on, but I fear it may take a change to the tax code. And that would require an act of Congress. Our Congress.

I won't hold my breath.

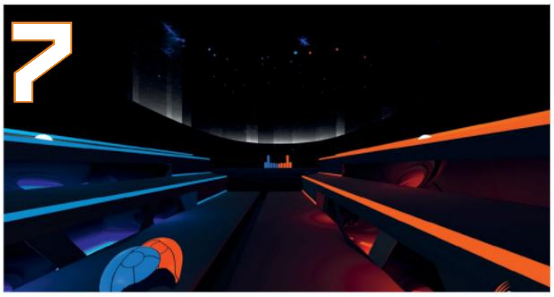
Alex Campbell is a Linux geek who enjoys learning about computer security.

THE LIST

EIGHT VIVE LAUNCH GAMES



FANTASTIC CONTRAPTIONS Like *Poly Bridge* had a baby with Rube Goldberg, then took steroids.



AUDIOSHIELD *Audiosurf* plus *Ikaruga* meets virtual reality….

FINAL APPROACH A unique simulation game that's one part helicopter sim and one part *The Sims*.

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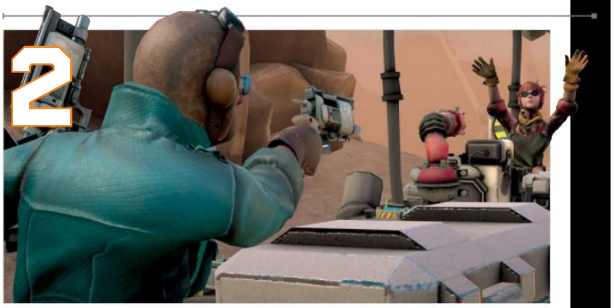
JOB SIMULATOR: THE 2050 ARCHIVES Re-enact mundane jobs in the not-so-dystopian future.

THE GALLERY: CALL OF THE STARSEED Adventure inspired by '80s fantasy and sci-fi movies.



HOVER JUNKERS A *Mad Max*-inspired multiplayer shooter set in a futuristic desert.

CLOUDLANDS It really feels as though you're playing mini golf within the confines of your home.

Windows 10

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DOCTOR

THIS MONTH THE DOCTOR TACKLES...

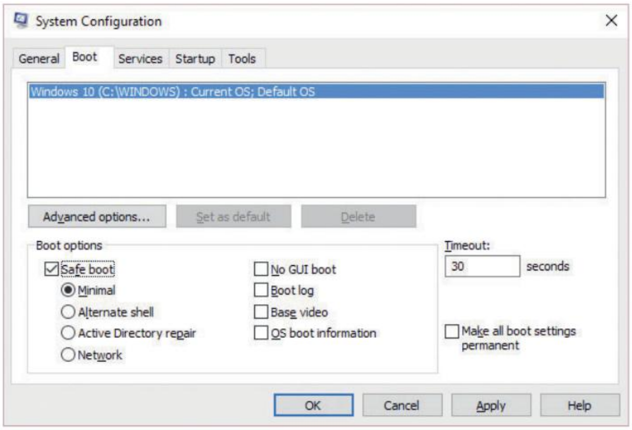
> Entering Safe Mode
> M.2 Frustrations
> Win 95 Security

Getting Into Safe Mode

Hello Doc, in a fairly recent issue, you described how to access the Windows 10 boot menu for entering Safe Mode. Would it be possible for you to send me the directions? I know it had something to do with pressing the Shift or Alt key before or during the reboot process, but I can't remember the exact instructions, nor can I find that issue. Please assist with this one! **–Carl Smith**

THE DOCTOR RESPONDS: There are a few ways to get into Safe Mode. The one you're probably referring to involves opening the "Start" menu, clicking "Power," and then selecting "Restart" with the Shift key held down. Your PC should then reboot to a screen that asks you to choose an option: "Continue," "Troubleshoot," or "Turn off your PC." Click "Troubleshoot," then "Advanced options," and finally "Startup Settings" (yes, the Doc knows, this is way more convoluted than it needs to be). From there, click "Restart." The operating system restarts and you're given several options, three of which include Safe Mode. Pick the one most appropriate to your situation, and you're on your way.

Alternatively, right-click the "Windows" button, click "Run," and enter msconfig. Click the "Boot" tab, and check "Safe boot." Click "OK" and Windows prompts you to restart, kicking you into Safe Mode.



System Configuration

Windows 10 (C:\WINDOWS) : Current OS; Default OS

Boot options

☑ Safe boot
● Minimal
○ Alternate shell
○ Active Directory repair
○ Network
☐ No GUI boot
☐ Boot log
☐ Base video
☐ OS boot information

Timeout: 30 seconds

☐ Make all boot settings permanent

Familiarize yourself with msconfig.exe—it's great for managing services, launching tools, and configuring the boot process.

Should something go awry, preventing you from booting up normally, it's good to have a recovery drive handy. Use the search feature to find "Create a recovery drive." Make sure "Back up system files to the recovery drive" is checked, and click "Next." Connect an 8GB or larger flash drive, click "Next," then "Create." From there, you can boot to Safe Mode (make sure your motherboard's boot priority has USB above SATA- or PCIe-based storage) by choosing a keyboard layout, and picking "Troubleshoot → Advanced Options → Startup Settings → Restart."

Better Performance

Hey Doc, I have a question about Internet speed that's been bugging me. I play a lot of first-person shooters—mainly *Battlefield* and *Call of Duty.* I think I have a pretty decent system for those titles: an Asus Maximus VII Hero, an Intel Core i7-4790K, 16GB of DDR3, a Samsung 750GB 840 EVO, and Windows 10 Professional. Here's the thing: I have a Fios 75/75Mb Internet connection in New Jersey. Is there a point where Internet speed no longer factors into gaming performance? We don't (yet) do any video or audio streaming, so bandwidth shouldn't be a problem. **–Steve Vanetti**

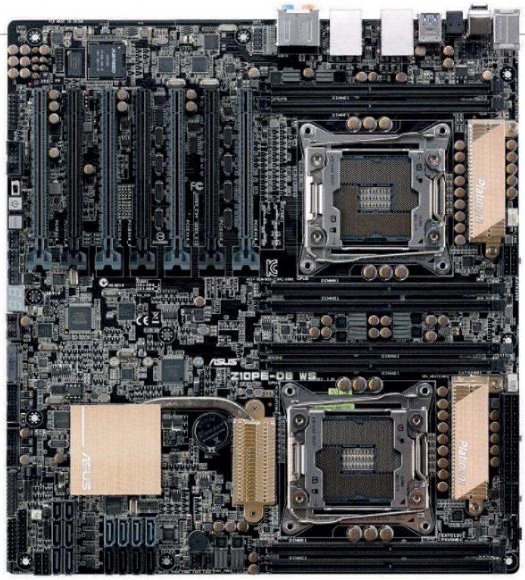
THE DOCTOR RESPONDS: A question similar to this came up a couple of months back, and it turned out that online gaming isn't very bandwidth-intensive at all. Although games vary in the amount of throughput they chew up, their demands are lighter than streaming audio, much less video.

You didn't say anything about performance issues, but the Doc noticed the missing graphics card mention. If you're seeing a slow-down or stuttering of any sort, it's possible that's your bottleneck—particularly in *Battlefield,* which is more GPU-bound than *Call of Duty.*

M.2 Frustrations

Hey Doc! I purchased an Asus Z10PE-D8 WS motherboard that supports bootable M.2 drives back in November. I have spent hours on the phone with company reps and a couple of techs, and I've scoured the Internet collecting information on how to configure this board so that Windows 7 sees the M.2 SSD as a bootable device, all to no avail. At this point, I'm ready to clean it up, take pictures, and

↘ submit your questions to: doctor@maximumpc.com



Asus's Z10PE-D8 WS is an immensely flexible workstation mobo. Its many options require a more advanced user to configure correctly.

put it on eBay for sale at a cut-rate price.

I am using a Samsung SM951 purchased from Newegg. And I have used this M.2 SSD in two other machines hosting ASRock X99 OC Formula and MSI X99 Mpower motherboards, both without any issues. Any suggestions? **–Irvin J. Halter**

THE DOCTOR RESPONDS: The Doc's original (and no doubt unpopular) suggestion would have been to give Windows 10 a try. However, he wanted to get a more technical explanation straight from the source. Asus's representatives responded with the same advice, though. You'll encounter the fewest compatibility problems and enjoy the best possible performance by setting your Option ROMs to UEFI mode in the "Advanced" tab's "CSM Configuration" menu and going from there. That's not to say the Z10PE-D8 is blameless for your frustration, while other motherboards are more easily made to work under Windows 7, but at least there's an easy workaround in sight.

Windows 95 Security

Doc, I'm in trouble. My Dell Inspiron 800 with a Pentium-class processor and 60MB hard drive, running Windows 95, is stuck at the log-in screen. I haven't used it in more than two years, and I've forgotten the password. I stopped using it because it was showing the symptoms of a virus, but Norton Antivirus couldn't find anything.

Is it possible to recover or clear my password so I can create a new account, perform a controlled upgrade, and recover my data? I have Windows 7 and Windows 8 upgrade discs. Or should I upgrade to Win 10? **–David Plotke**

THE DOCTOR RESPONDS: Let's start with your first issue: getting into Windows 95 so you can recover whatever information might be on that hard drive. When prompted to log in, press "Cancel" instead. This should get you into the operating system, albeit without network access. Hit "Start," then "Find." Search for all files with the *.pwl extension, then delete them. The next time you go to log in, the password should be blank.

Once you grab those files, find the nearest recycling center and drop that Inspiron off. Surely it's approaching 20 years old, right? Windows 7 requires a DirectX 9-class graphics device, and it's probable that you don't have the requisite 1GB of RAM installed. Windows 8 asks for processor features your Pentium lacks. You get the idea. No modern OS will run sufficiently well to make an upgrade worth attempting—and that's assuming your 60MB hard drive is really a 60GB repository.

Can I Upgrade?

Greetings, I have an excellent 17-inch laptop, but its discrete graphics module seems to have died. It was a GeForce GTX 670M with 3GB GDDR5. I'm now running some games on the integrated Intel HD Graphics 4000 engine, but as you know, that's pretty slow. I'd like to replace the card, but I can't find a seller other than eBay. Is that the only option? Also, I don't need such a fast GPU for most of my games; what would you recommend for older engines, like the ones used in *StarCraft* and *Diablo 3?* The specs are: MSI GT70, Intel Core i7-3610QM, 17.3-inch 1920x1080 display, 16GB DDR3 RAM, 128GB SSD, 500GB hard drive. **–Mike Abed**

THE DOCTOR RESPONDS: Based on the specs, that appears to be a 2012-era GT70. Unfortunately, MSI was not using replaceable modules back then, so your best bet for a working GPU is something scrapped from another laptop. eBay may indeed be your only hope.

These days, MSI has its GT72 and GT80 platforms, both built to accommodate upgrades. Several online vendors sell do-it-yourself kits that include an MXM graphics module, cooling solution, thermal compound and pads, and documentation. None of this helps you out of your current conundrum, but it's nice to know that today's gaming notebooks are more enthusiast-friendly.

Stop the Slowdowns!

Hi Doc. In spite of countless upgrades, my PCs have less "snap" than when they were new. My old Quantex was more responsive. I'm in a never-ending cycle of trying to figure out why my machines are so slow. I'm in Safe Mode 10 times a year troubleshooting causes. After a peek at Task Manager's 46 background processes, there is no way to tell up from down. I need a hands-on service to keep my PC tuned.

I worked with USN EAM equipment in the '60s and IS until I retired. I want to browse out the rest of my PC time unencumbered by Safe Mode expeditions. There must be services out there to subscribe to on a monthly or yearly basis. **–Michael McLaughlin**

THE DOCTOR RESPONDS: The Doc wonders how many of his fellow enthusiasts started their advanced computing careers troubleshooting some frustrating behavior and falling in love with that little victory. There's no magic, just a knack for sniffing out symptoms and applying the right medicine.

There's a handful of reasons our PCs slow over time. You install software on a clean copy of Windows and boot-up takes longer. More resources are consumed in the background. You don't want some apps anymore and they're uninstalled sloppily. New software pushes your old hardware harder. And maybe you end up with some malware, which lurks behind an innocuously named entry in the Task Manager.

Many repair services would love your business. But the Doc wouldn't recommend any of them. Rather, lean on your fellow enthusiasts for help. Make liberal use of Google. Exercise discretion when it comes to installing software. Also, keep balance in mind when you do throw money at an upgrade. The fastest CPU in the world won't make your games run any faster if it's a graphics bottleneck holding you back.

Steer Clear of Adware

You suggested downloading the Advanced System Uninstall app. But it's very aggressive adware that stops CCleaner running, and it won't uninstall through Control Panel. **–Gregory Watts**

THE DOCTOR RESPONDS: Not only has the Doc never recommended Advanced System Uninstaller, but he's also never heard of it. But your point stands: Before you load up on third-party utilities, do your homework. Few freeware apps perform their promised duty with no strings attached.

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- 8GB DDR4-2133MHz Memory
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- 30 days No Dead Pixel Guaranteed Insurance
- 3GB DDR5 NVIDIA® GeForce™ GTX 970M GPU
- 16GB Dual Channel DDR4-2133MHz Memory
- 250GB Samsung 850 EVO M.2 SSD + 1TB 7200RPM Hard Drive
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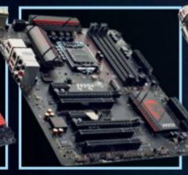
MOTHERBOARDS ON TEST

ASRock Fatal1ty B150 Gaming K4/D3



MSI B150 Gaming M3

MSI Z170A Tomahawk

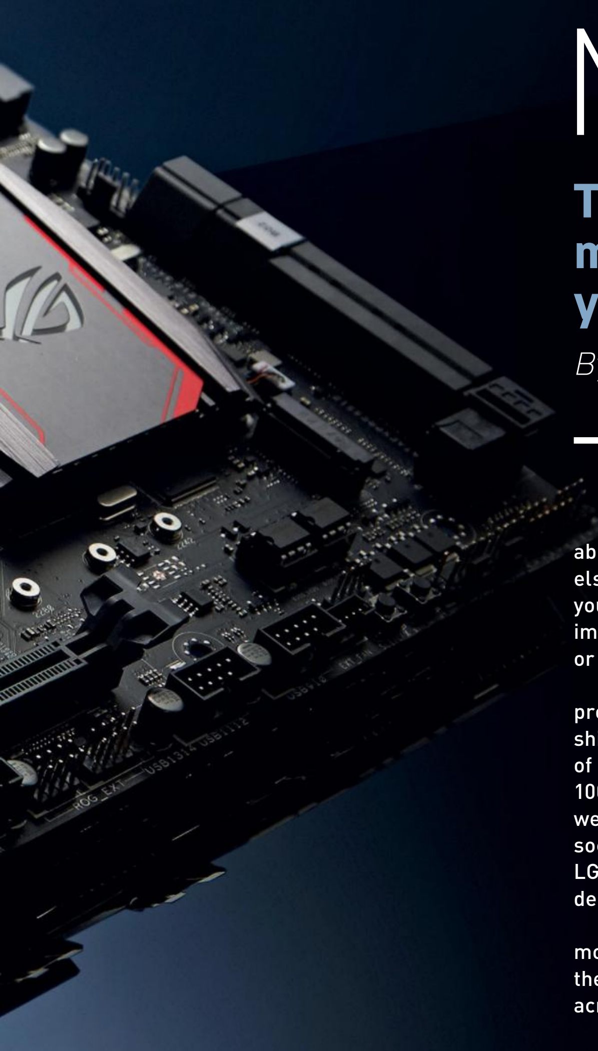
Asus Z170i Pro Gaming

Gigabyte GA-170X-Gaming 5

MSI Z170A Gaming Pro Carbon

Gigabyte GA-Z170X-Gaming 7

MSI Z170A Gaming M7



SKYLAKE Motherboards

The 100-series motherboards have matured beautifully, but which should you build your next rig around?

By Dave James

The motherboard may not be the sexiest of components, but it's the part of your PC that you build your system around. It dictates more about the rest of your rig than anything else, so making the right decision about your motherboard is arguably the most important choice you make when building or upgrading.

With Intel's latest 6th Generation Core processors, code-named Skylake, we've shifted from the 9-series motherboards of Haswell and Broadwell, to the new 100-series. And that's partly because we're also talking about a whole new socket design—a move from the previous LGA 1150 socket to the new LGA 1151 design. Yeah, a whole extra pin.

But the new 100-series boards offer more than a subtle new socket design; there are important new features across all the different iterations of the 100-series. And, like the previous generations, these ranges are directly comparable to what's come before. There are six new chipsets available for Skylake—H110, H170, B150, Z170, Q170, and Q150—though we only really need concern ourselves with half of them.

The H110 is the lowest of the low-end boards, while the Q-series is aimed 100 percent at the business market, with a focus on Intel's Small Business Advantage and Intel Stable Image Platform features.

For us, then, the Z170, H170, and B150 are the boards we're more interested in, catering to the high-end, midrange, and the budget sections of the components market. But what do you get for your money with each of the new chipsets, and which should you commit to building your next rig around? These are vital questions, so aren't you lucky you've got us to help make your decision easier?

Asus Maximus VIII Formula

Asus Maximus VIII Extreme

The switch to the 14nm Skylake processors has brought some notable new features for its motherboard companions. The most prominent are support for DDR4, the move to PCIe 3.0 connections from the chipset, and the chipset offering a much greater number of those lanes.

That's in addition to the 16 lanes of PCIe 3.0 that you've had in the last few generations of Intel processors. This shows the increasing reliance on PCI Express as an interconnect, not just for graphics but for next-gen storage, too. Intel introduced DDR4 and vast numbers of PCIe lanes with its Haswell-E processors, but the X99 chipset still only supports eight last-gen PCIe 2.0 lanes.

So the 100-series chipsets are the most advanced consumer motherboard silicon Intel has produced. The top end of the Skylake mobo spectrum is the Intel Z170 chipset. It's the logical successor to the Z97 used for the Haswell and Broadwell generations, and as such incorporates everything the 100-series can offer.

Of the consumer-focused mobos—as opposed to the business-centric Q-series—the Z170 contains the largest number of PCIe 3.0 connections, featuring 20 lanes from the chipset itself. Compared to the relatively miserly eight PCIe 2.0 lanes offered on the old Z97 and the high-end X99 chipsets, that's quite a boost for the multi-GPU faithful, as well as the NVMe aficionado; and means you can now use both together.

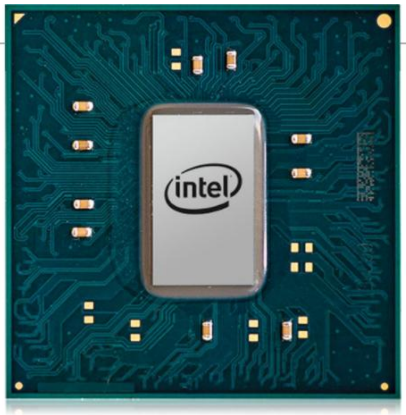
The 20 lanes are split up over five x4 controllers, enabling you to run them as x1, x2, or x4 lanes. Three of the controllers will be covered by the Intel Rapid Storage Technology (RST)—which maximizes performance, especially in solid-state drives—so you could add up to three PCIe SSDs covered by RST without taking away any of the lanes for your graphics array.

That will take up all the SATA ports supported by the chipset itself, though. So if you were to go down that storage path—and your motherboard doesn't have a third-party SATA controller—you'd need to find a separate SATA controller if you still wanted to use some legacy storage.

So in extreme cases, there will still need to be some PCIe juggling, such as when lots of GPUs and PCIe-based SSDs are installed, but nowhere near what the serious enthusiast had to deal with before.

DDR4 options

DDR4 memory support doesn't actually come from the motherboard chipset per se—the memory controllers are baked into the processors themselves—but different levels of motherboard offer different memory configurations.



The top-spec Z170 chipset represents the full goodness of the Skylake platform.

The most straightforward part is that they're all dual-channel, but the Skylake architecture gives the CPUs both DDR4 and DDR3L memory controllers. That means you can get Skylake boards with either DDR4 or DDR3L, and some manufacturers are even creating boards with both.

Thankfully, it's mostly shaking out that the Z170 chipset, as the high-end offering, is going to be pretty much 100 percent DDR4, at least for the current boards.

This means that as well as a CPU and motherboard upgrade, you're also going to have to factor in a memory upgrade. Luckily, the price premium on DDR4 over DDR3 has dropped considerably recently, now that it's become more mainstream.

Midrange step down

The step down from the top-end Z170 chipset is the H170. It loses out compared to its smarter sibling in the numbers game, having only 16 PCIe lanes attached to the chipset as opposed to the Z170's 20. Linked to that, you only get Intel's RST on a pair of the x4 PCIe controllers, instead of three.

Those 16 lanes still represent twice the capacity of the top chipset from the last generation of Intel silicon, however, making the H170 still a very worthy consideration.

Elsewhere, the H170 only supports eight USB 3.0 connections compared to the 10 of the Z170 boards, and only has four native SATA 6Gbps connections, too.

The H170 chipset also restricts the CPU's PCIe lanes to only running at x16, rather than being able to split into x8/x8, or x8/x4/x4, as with the Z170. That will make the majority of H170 motherboards sub-optimal for budget multi-GPU solutions.

Business up-front, LAN party behind

Ostensibly, the B150 chipset is more geared toward business users, though the ASRock board in this month's roundup attests to the fact that it's still going to be used by manufacturers as a budget gaming option.

The chipset itself is again cut-down compared to the H170 and Z170 silicon,

Z170 PCI Express Lanes

1	USB 3 #1 *(Capable of OTG)*					
2	USB 3 #2					
3	USB 3 #3					
4	USB 3 #4					
5	USB 3 #5					
6	USB 3 #6					
7	USB 3 #7	PCIe #1		x4	x2	
8	USB 3 #8	PCIe #2				
9	USB 3 #9	PCIe #3			x2	
10	USB 3 #10	PCIe #4	GbE			
11	PCIe #5		GbE	x4	x2	
12	PCIe #6					
13	PCIe #7				x2	
14	PCIe #8					
15	PCIe #9	SATA #0	GbE	x4	x2	Intel PCIe storage device #1
16	PCIe #10	SATA #1				
17	PCIe #11				x2	
18	PCIe #12		GbE			
19	PCIe #13	SATA #0	GbE	x4	x2	Intel PCIe storage device #2
20	PCIe #14	SATA #1				
21	PCIe #15	SATA #2			x2	
22	PCIe #16	SATA #3				
23	PCIe #17	SATA #4		x4	x2	Intel PCIe storage device #3
24	PCIe #18	SATA #5				
25	PCIe #19	SATA #6 *(Server only)*			x2	
26	PCIe #20	SATA #7 *(Server only)*				

with only eight PCIe lanes, and a maximum of six USB 3.0 connections. It does up the game in terms of SATA connections, though, retaining the six 6Gbps of the Z170.

In terms of memory, the B150 and H170 boards are where you'll see DDR3 and DDR3L support make an appearance.

Overclocking

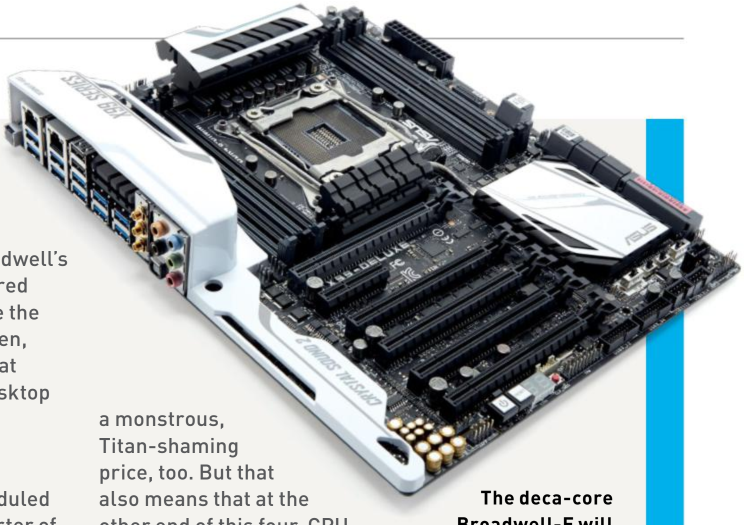
The elephant in the room is overclocking support. The hard and fast rule with Skylake is that if it isn't on a Z170 chipset, it isn't getting overclocked. Though that's what Intel said with previous generations, before every manufacturer let you boost K-series clocks across the board.

Things are different with Skylake, though, and despite the fact that you can baseclock boost non-K-series processors on the Z170, you can't mess with the multipliers on most H170 or B150 boards. Although manufacturers can provide a modicum of support for CPU overclocking, it will generally come at the expense of Hyper-Threading and C-States.

If you're rocking a Core i5, that's not an issue, and you'll be able to pick up an ASRock board with a modified H170 chipset and make good with the overclocking. But those with an i3 or i7 are going to struggle—any overclocked boost will be negated by losing out on Intel's Hyper-Threading tech.

So that's the basic overview of the chipsets, but how different are the motherboards within those brackets? We've collected 10 boards, from all the major manufacturers, to find out who comes out on top with Skylake.

Broadwell's Back



The deca-core Broadwell-E will apparently be $1,500.

If you thought Broadwell's pair of mostly ignored desktop chips were the last gasp for that gen, you've forgotten that Intel's high-end desktop parts are always a generation behind.

So next we have Broadwell-E, scheduled for the second quarter of this year. As you might expect, Broadwell-E is the 14nm die shrink of the Haswell-E processors, cribbed from the high-end Xeon server parts of the range. As such, it's all about multi-core performance, and this is where Intel has continued its core push, leaving the standard desktop chips to stagnate at four cores.

Haswell-E brought the first straight eight-core consumer CPU from Intel, and Broadwell-E is set to deliver us a 10-core/20-thread monster in the Core i7-6950X—reportedly for a monstrous, Titan-shaming price, too. But that also means that at the other end of this four-CPU range will be a "low-end" Core i7-6800K, offering a six-core/12-thread alternative for just $400.

However, thanks to the fact it's essentially just die-shrunk Haswell-E, Broadwell-E will drop right into the LGA 2011 v3 socket of pretty much any X99 motherboard... so long as the BIOS gets an update first. Manufacturers are likely to bring out special-edition boards to coincide with the launch of the first deca-core consumer chip, but there should also be some mature, reasonably priced X99 boards just waiting for that cheaper six-core CPU.

You can bet that Broadwell-E won't drop if Skylake is still doing decent numbers; there's little chance Intel will want to risk the $400 i7-6800K taking any of the shine off the $390 i7-6700K. Despite going back generationally, the enthusiast is going to look at those two platforms and be tempted to go for the hexa-core version, even if the motherboard is potentially going to be a touch more expensive.

Intel 100 Series Chipsets

	Feature/Capability	Q170	Q150	B150	H110	H170	Z170
Chipset I/O	PCI Express Gen 3 Lanes	Up to 20	10	8	6 (Gen 2 only)	Up to 16	Up to 20
	SATA Gen 3	Up to 6	Up to 6	Up to 6	4	Up to 6	Up to 6
	USB 3.0	Up to 10	Up to 8	6	4	Up to 8	Up to 10
	Total USB Ports (USB 2.0 & 3.0)	14	14	12	10	14	14
	SATA Express Capable Ports (x2)	Up to 3	Up to 1	Up to 1	0	Up to 2	Up to 3
	Intel RST for PCIe Storage Ports (x4 M.2 or x2 SATA Express)	Up to 3	0	0	0	Up to 2	Up to 3
	Enhanced SPI	Yes	Yes	Yes	Yes	Yes	Yes
CPU	PCI Express Gen 3 1 x16 Port	x4, x8, x16	1 x16	1 x16	1 x16	1 x16	x4, x8, x16

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ASRock Fatal1ty B150 Gaming K4/D3

Odd upgrade decisions

WE DON'T UNDERSTAND ASRock's naming scheme. Fatal one ty? What's that? Well, it's a brand that's proudly paraded as the gamer's motherboard of choice from this particular company. But how does it compare with the world of Skylake, particularly with the B150 chipset?

You'll notice that this model is backward compatible with the aging yet dependable DDR3 standard. Of course, if you choose that path, you'll lose out on the additional bandwidth, lower voltages, and higher capacities of DDR4.

That choice aside, this motherboard's a little too thin on features. There's a total of six SATA 6Gb/s ports, support for DDR3 at 1,866MT/s, Killer LAN, and a fancy audio solution, but that's about it. In fact, the PCB appears to be a stripped-down version of the B150's more sophisticated Z170 brother—even the M.2 slot retains signs of where it was to be soldered in.

As far as performance goes, the B150 chipset has very limited overclocking capabilities. By "limited" we mean none. There's no support for XMP profiles either. Otherwise it performs as you'd expect. There's very little deviation from the other test results, except in the overclocked benchmarks and memory bandwidth. It's also worth noting that although the BIOS states that Intel's Turbo technology is enabled, we only ever saw our Core i7-6700K top out at 4GHz, as opposed to its 4.2GHz max.

If you're only interested in a small upgrade to a Core i5-6600, with a better audio solution and support for two-way Crossfire/SLI, this board is ideal. However, if you're still on Devil's Canyon, Haswell, or even Ivy Bridge, certainly for gaming, you're not going to get a lot more out of it. Short of additional USB support, and an upgrade to 8x PCIe 3.0 lanes over Z97's 8x PCIe 2.0 lanes, that's all there is to it.

VERDICT
6

ASRock Fatal1ty B150 Gaming K4/D3

+ **KILLING SPREE** Affordable; acceptable stock performance.

− **FATALONETY** Lackluster feature set; B150 is a tad tame; not much different from Z97; turbo is a lame duck.

$100, www.asrock.com

MSI B150 Gaming M3

B150 done right

THIS IS HOW B150 should be put together. A clean, slick, black-and-red gaming motherboard, with just enough bells and whistles to keep you happy. No doubt you're still going to lose out compared to the likes of the Tomahawk and its Z170 chipset, but if you're putting together an entry-level gaming PC, this may well be your best bet.

For $110, you get two PCIe 3.0 16x slots, support for up to 64GB of DDR4 at a maximum of 2,800MT/s, six SATA 6Gb/s, one SATA Express port, and one M.2 slot, although not of the PCIe x4 variety, so no super-fast speeds for you. On top of that, you get a separate PCB for audio, Killer Gigabit LAN, plenty of USB 3.0 ports, and the heady software package that comes with it, including Nahimic's audio enhancer, and MSI's desktop software package.

Performance wise, we're delighted to inform you that, again, it's almost exactly the same as the others. Short of reduced potential in CineBench and rendering tasks, (due to the lack of suitable turbo headroom or overclock potential), that's all there is to it. Fortunately, it doesn't suffer from the ASRock's lack of memory bandwidth, and the power draw is well within reasonable levels—in fact, it pulled less from the wall than any other board.

Think of it as a mix of Z97 with Z170, leaning more toward the last generation of motherboards. It's a stepping stone for those making a jump from something like Z77, intending to purchase a more powerful, well-equipped system at a later date. Buy this board, a Core i5-6600, and 16GB of DDR4, and you have a cheap and easy solution. Throw in your old GPU, and you're good to enjoy Skylake's additional processing power. Wait three to four months and some new GPU will surface, buy a new Z170 mobo and a fancy GPU, and wham, you're all up to speed, without having to break the bank in one go.

VERDICT
8

MSI B150 Gaming M3

+ **MIGHTY** Upgrade potential; good price; DDR4 support; better than Z97.

− **MILD** M.2 not PCIe; PCI slots.

$110, www.msi.com

MSI Z170A Tomahawk

Value king

MSI'S Z170A TOMAHAWK comes in at a very affordable $150. At that price, you'd probably expect a very basic, very stripped-down Z170 feature set to match. But short of a few aesthetic features, that's not the case.

The Tomahawk comes with two PCIe x16 slots, one M.2 PCIe x4 slot, six SATA 6Gb/s ports, two SATA Express ports, and support for DDR4 up to 3,400MT/s. Couple that with integrated Wi-Fi and Bluetooth, and you're looking at a capable setup for this little board, to say the least.

As far as aesthetics go, you may not get the gorgeous finish littering the heatsinks and rear I/O cover of the likes of the Gaming M series, nor do you get the reinforced backplates. But the styling still looks pretty snazzy—if you want to extra bling, you're going to have to pay for it.

The MSI Z170A Tomahawk performed as well as all of its competitors, maxing out our CPU at 4.9GHz, and netting the highest PC Mark 8 score out of the lot, at 4,153. Any downsides? Well, memory bandwidth suffered by 2GB/s, and overall overclocked performance in CineBench did seem a little low compared to some of the others in this test, but not enough to warrant concern, that's for sure.

Ultimately, this is the pinnacle of budget Z170 in our eyes. It's aimed at those not looking to break the bank when putting together a machine. Those wanting to make the most out of their cash. Those that don't need the LEDs, or the option to LN2 cool their boards—it's all about making a system that performs admirably, and dumping as much money as they can into the GPU and CPU portions of their builds. On top of that, it's the perfect board for anyone looking to advance early and upgrade later. The addition of an M.2 slot ensures you can stay up to speed with some of the best storage potential out there, and the overclocking capacity is nothing to ignore either.

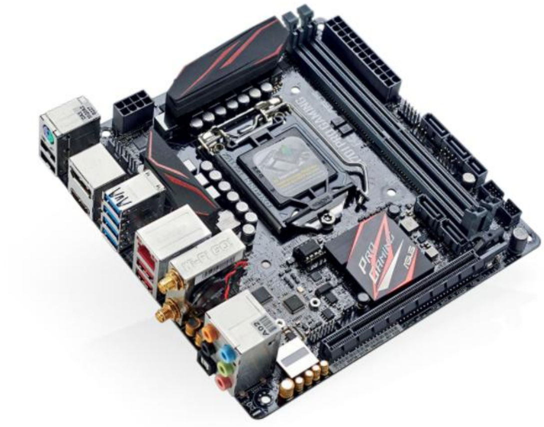
VERDICT
9

MSI Z170A Tomahawk

+ **BATTLEAX** Strong feature set; good performance; great price; expandability.

− **AXFACE** Aesthetically uninspiring.

$150, www.msi.com



Asus Z170i Pro Gaming

Who needs ATX anyway?

2016 IS THE YEAR of the ITX chassis. Just take this motherboard—there's no reason why you couldn't throw in a Core i7 clocked at 5GHz, 32GB of 3,000MT/s DDR4, AMD's R9 Fury X, a Samsung 950 Pro 512GB, and a separate RAID 0 array. Enough said.

So, what does this 6.7-inch square provide? You've got the standard 8-pin and 24-pin power, a solid overclocking VRM solution, support for DDR4 at 4,000MT/s, four SATA 6Gb/s ports, one SATA Express port, dual-band Wi-Fi and Bluetooth 4.1, and a full complement of premium audio capacitors, DAC, and headphone amplifier.

The most interesting part of this tiny mobo, however, is the M.2 slot. Space is always going to be a precious commodity for an ITX system, and ultimately something has to give—usually, it's M.2. Fortunately, Asus disagrees, and has placed the M.2 slot on the underside of the PCB. Where its out of sight and cooler that it would be on top. This way, ITX enthusiasts—yes, they do exist—get to take advantage of those PCIe storage speeds we all love.

As far as performance goes, it's a similar affair across the board. CineBench did see a slight drop in stock performance here, but it still outperformed a fair few of its thuggish competitors in the Tech ARP's x264 benchmark. What really blew us away was how well it overclocked. With a quick and easy bump up to 1.41V, the Z170i Pro Gaming managed what has almost become our benchmark of 4.9GHz on our i7-6700K, with no problem.

This motherboard aims to please two groups: those looking for a budget Z170 mobo, and those looking to pack all of Skylake's features into ITX. And it's achieved this admirably, with very little in the way of problems.

VERDICT
8

Asus Z170i Pro Gaming

+ **PRO** Great price; strong feature set; intuitive M.2 implementation; strong performer.

− **SLOW** Aimed at a niche demographic; no rear I/O cover; no angled USB header.

$165, www.asus.com

Gigabyte GA-170X-Gaming 5

Best budget board?

GIGABYTE HAS ALWAYS had a flair for design, and Z170 is no exception. In a PC gaming world dominated by black and red, it's a nice change to see a manufacturer try to stand out from the herd. The Gaming 5 is stylish mix of black, red, white, and silver—it looks great in a windowed case.

At its heart, you'll find that trusty and well-armed Z170 chipset, supporting three PCIe 16x slots, three SATA Express connectors, six SATA 6Gb/s connectors, a plethora of onboard USB support, and two PCIe x4 M.2 slots, both capable of supporting RAID 0 among other arrays. That's pretty rare in itself, and for a board at this price, it's damn impressive.

Performance-wise, it's one of the better boards at this price point. In our rendering tests, the GA-Z170X-Gaming 5 shone through the muddy battlefield of our motherboard supertest and came out, more often than not, near the top three in almost every scenario. And somehow it managed to do all this while maintaining an exceedingly low power draw, meaning in the long run, it'll make less of an impact on your wallet—impressive work.

Gigabyte's BIOS, on the other hand—well, that's another story. It's one of the least intuitive UEFI BIOSes we've ever had to work with. Even getting Intel's Turbo speedstep tech to work took us four attempts. Seriously, Gigabyte, it's 2016—we understand that it's not a super-integral part of a system, but a clean, swanky BIOS makes life so much nicer. That said, once we did manage to kick the little chip into overdrive, the benchmarks truly let rip.

The Gigabyte GA-Z170X-Gaming 5 is a fantastic motherboard, filled to the brim with more features than you could want, certainly for the price. For those looking to step into the rich world of Skylake's Z170 chipset, you could do a lot worse than snap up this lovely little board.

VERDICT

8

Gigabyte GA-170X-Gaming 5

⊞ **GIGABYTE** Performance; alternate design; aggressively priced.

⊟ **GIGABIT** BIOS; Turbo disabled by default.

$167, www.gigabyte.com

MSI Z170A Gaming Pro Carbon

Carbon-fiber gaming confirmed

MSI HAS PROVIDED MILITARY CLASS motherboards for as long as we can remember but this is possibly the first time we've ever seen carbon fiber on a motherboard. Or rather, carbon-fiber styling. The Z170A Gaming Pro Carbon is similar in a lot of ways to Asus's Maximus VIII Formula. It's a sophisticated development in the line of Z170 chipsets.

Interestingly, MSI only ever released one RGB-lit Z170 motherboard—the Carbon's older brother, the Gaming Pro—but it was criticized for color clashing. So now we have the Gaming Pro Carbon, a black and gray variant of this entry level gaming motherboard.

So what do 170 bucks buy you? Other than those flashy lights, you get a PCIe x4 M.2 port, six SATA 6Gb/s ports, one SATA Express port, a plethora of USB 3.0 options (including our favorite, a right-angled header), three PCIe slots, and support for DDR4 up to 3,600MT/s OC.

How did it perform? Very similarly to the other boards. The highest overclock we managed was 4.9GHz, just like the rest of them, bar the B150s and Asus's Maximus VIII Extreme. Otherwise it was almost identical across the board, short of a slight slump in memory bandwidth.

Using the Gaming Pro Carbon was a dream. The BIOS, although not as intuitive as some, is more than capable of holding its own, and the software suite is great. The inclusion of Nahimic's audio processing software is awesome, and couple that with dual headphone amps, and you're in for a fun experience in game. The RGB lighting is kinda cool, though it might come across as a bit cheesy.

When it's down to the wire, the Gaming Pro Carbon is a solid choice. It has a few niggles, mostly due to its aesthetics and a lack of support options, but otherwise that's all we can really say about it. Smooth as a whistle.

VERDICT

8

MSI Z170A Gaming Pro Carbon

⊞ **MCLAREN** RGB lighting; performance is solid; great power draw at peak.

⊟ **COAL** No secondary M.2 slot; board is bare; carbon finish not to everyone's taste.

$170, www.msi.com

Gigabyte GA-Z170X-Gaming 7

So much swagger

LOOK AT THAT WHITE REAR I/O cover. Go on, take a peek. It's stunning. We mentioned earlier how Gigabyte is breaking the mold with its new board designs, and nowhere is this more apparent than with the Gaming 7. The white rear I/O cover draws your attention faster than Kanye West can make a fool out of himself. And wow—does it look good.

What else is interesting about the GA-Z170X-Gaming 7? Beside the dual PCIe x4 M.2 slots, Thunderbolt 3 support, upgradeable OP-AMPs, noise-canceling power design, integrated HDMI 2.0—that spec AMD doesn't yet support on its current GPUs—dual networking solutions, and the elegant RGB lighting embedded into the rear I/O cover? Well, it does support DDR4—that's pretty cool, right? The number of features here is nigh-on incredible.

As usual, our testing found the Gigabyte Gaming 7 to be as strong as all the others. In almost every benchmark it did just as well, short of a small hiccup with memory bandwidth. You do still have to deal with that awful BIOS, but it's a far smoother experience overclocking and tweaking it than with the Gaming 5.

Ultimately, we had no problems with the Gaming 7. It's a feature-rich board, designed to draw your attention. The rear I/O cover is divine, and the RGB lighting—although somewhat confusing, because of the color implemented into the design of the board—is a smart touch.

Does it add much in the way of performance? Well, no, not really for the vast majority of us. If you can't afford to buy a pre-binned CPU, you're not going to get much more out of any of these motherboards. But, the feature set will always be king, and this is something that Gigabyte has nailed, with the Gaming 7. This motherboard is an incredibly compelling proposition.

VERDICT
9
KICK ASS!

Gigabyte GA-Z170X-Gaming 7

⊞ **GIGAJOULE** Radical design; strong performance; aggressive price; good audio; intuitive lighting; HDMI 2.0.

⊟ **JOULE** RGB lighting can clash; clunky BIOS.

$210, www.gigabyte.com

MSI Z170A Gaming M7

Premium, thy name is M7

AT $220, WE START to enter territory inhabited by additional features and aesthetic choices that really do make you go, "Ooooh!" The M7 is a prime example. One of the first MSI boards to feature a full rear I/O cover, it is a stunning example of black and red done right. The metallic finish across the heatsinks gives the board just enough pop to stand out. But that's not all this beastie can muster.

You have access to six SATA 6Gb/s ports, two SATA Express, two M.2 slots (but no RAID 0), three PCIe 16x slots, protected by the ever-popular steel reinforced brackets, and full support for DDR4 up to 3,600MT/s, if extra-voltage DDR4 is your thing. Fortunately, there's no garish RGB lighting, and the audio solution is quite the little number, supported by Nahimic's software suite.

One of the biggest features MSI is pushing with this board is its auto-overclock dial. Although it sounds great, in reality it is a little dubious. It acts as a BIOS profile button, guessing how much voltage need be applied to your Skylake processor, ramping up the multiplier in situ. Is it any good? Sort of. The thing is, if—like any sane person—you've installed this motherboard in a case, you're never going to have access to that little dial.

And performance? We're starting to feel like a stuck record. We achieved a maximum overclock of 4.9GHz, and all the other benchmarks were within less than 6 percent of one another in almost all cases, short of power consumption. The M7 did well overall, with a PC Mark 8 score above 4,000, but there really is little difference here.

Ultimately, it depends on your chip, how you like your motherboard to look, and whether the audio is any good. Fortunately for the M7, the latter two work incredibly well in its favor. But if you're after a performance motherboard? Well, you might want to think again.

VERDICT
8

MSI Z170A Gaming M7

⊞ **MAYHEM** Stunning looks; strong feature set; great all-round performance.

⊟ **MEH** Still pricey; game boost impractical.

$220, www.msi.com

Asus Maximus VIII Formula

Is this the king of mobos?

SKYLAKE INTRODUCED one of the most controversial features ever to grace the world of motherboards: RGB lighting. At first, ill-advisedly, manufacturers simply threw those little LEDs into their boards without much consideration for the potential color clash.

Fortunately, the Formula avoided such a fate. Thanks to a later release cycle, Asus took the opportunity to strip the motherboard of its color, leaving a very sharp, black-and-gray base for those LEDs to complement.

Benchmarking was, as ever, a smooth process. We achieved our maximum overclock of 4.9GHz with relative ease, and all our other benchmarks were in line with what we expected. Leaving us in no doubt that, beyond included features and software suites, there's not enough on the board at this point to make a considerable difference.

That aside, the Maximus VIII Formula includes a redesigned thermal armor and reinforcing backplate, the ability to hide an M.2 SSD south of the chipset, a fully integrated EKWB VRM heatsink, and an Intel U.2 port.

If only we could end here. However, we came across a small problem with all of the Asus motherboards. Recently, while updating our CPU benchmarks, we noticed that, at stock, our Intel Core i7-6700K performed far better than on competing boards—however, at 4.9GHz, the little chip lost around 5-6fps in game. Odd, to say the least. This ended up being a result of Asus's enhanced turbo settings, enabled in BIOS by default. Great at stock, less so for overclocking.

Ultimately, the Formula is a stunning piece of design. Although the RGB lighting isn't for everyone, the performance is there, and at the very least, the black and gray styling, and the feature set, should appeal to those looking to build a top-of-the-line system.

VERDICT
9

Asus Maximus VIII Formula

+ **CHAMPION** Great design; reiterated lighting; strong performer; balanced price.

− **CHUMP** A bit plasticky.

$400, www.asus.com

Asus Maximus VIII Extreme

The pinnacle of overclocking?

THE MAXIMUS EXTREME lineup has always revolved around one particular pastime: overclocking. If you look at the number of records broken by that fabled name, you'll realize there's more to these boards than mere marketing propaganda. The Maximus VIII Extreme has already broken six world records in overclocking competitions.

This is a motherboard designed to push Skylake to the limit. We're talking overclocks well above the 6GHz mark. But not everyone has a processor (or a cooling solution) capable of such high frequencies. So does that make this board useless for anyone else? Not entirely.

For the money, you get eight SATA 6Gb/s ports, two SATA Express ports, one M.2 slot, one of Intel's prestigious U.2 ports, support for DDR4 up to 3,866MT/s, and no fewer than four PCIe 3.0 x16 slots. Then there's the audio solution, including headphone amplifiers, Nichicon capacitors, a high-precision clock, and an ESS-ES9023P DAC. You get the point.

We pushed our CPU beyond its silicon limit. Increasing the core voltage to 1.425V, and with clever adjustments to the base clock, we achieved a stable overclock of 4.95GHz. Of course, that's only 50MHz more than we got on almost all of our other boards. And our consistency performance tests fell in line with the rest, too.

Aesthetically the Maximus VIII Extreme is stunning. Admittedly, putting RGB lighting on a motherboard with red accents doesn't make much sense, but it's there.

So who is this motherboard for? Overclockers. Those willing to test all of the CPUs out there in the hunt for those record-breaking numbers. It's a well-equipped board, looks stunning, and performs admirably. But in reality, does that make it any better than, say, the Maximus VIII Hero? For the vast majority, probably not.

VERDICT
8

Asus Maximus VIII Extreme

+ **MAXIMUM** Extreme OC potential; stunning design; rich feature set; U.2 port.

− **MINIMUM** Price; RGB lighting; niche product.

$485, www.asus.com

HOW WE TESTED

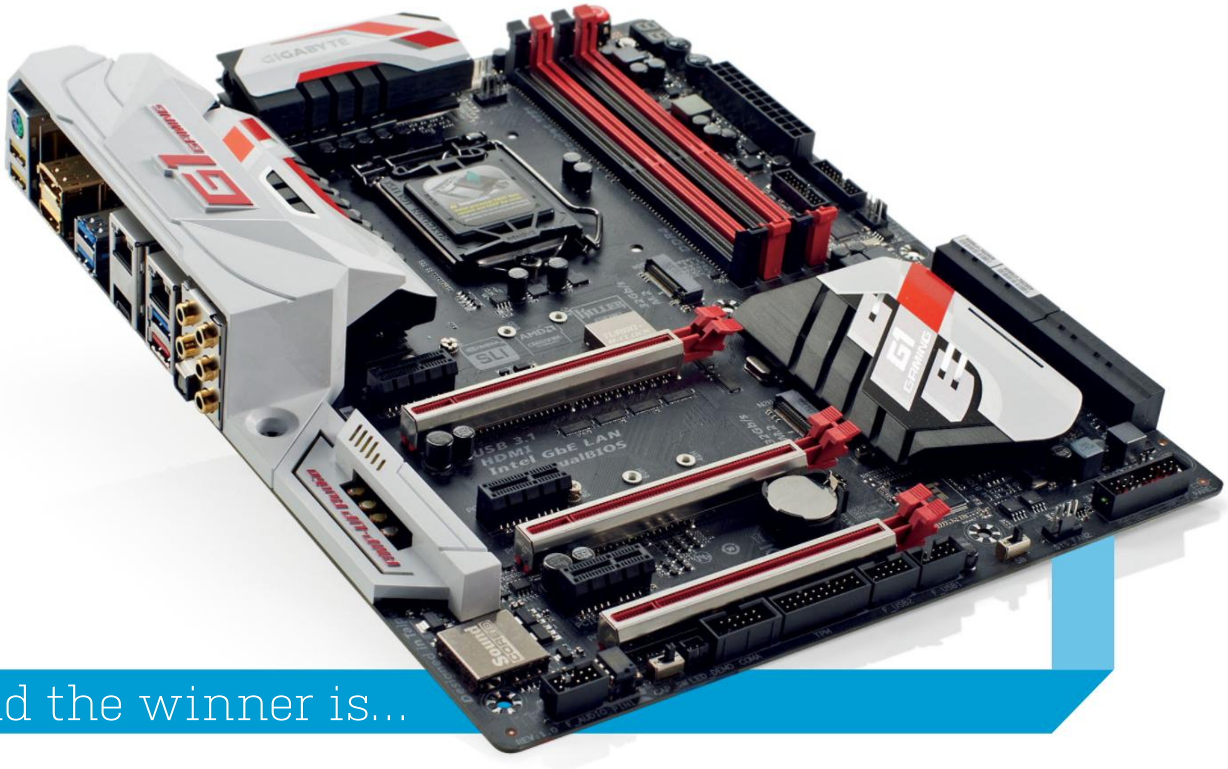
All of our motherboards were tested using 16GB of either DDR4 or DDR3 where appropriate, an Intel Core i7-6700K, a GeForce GTX 980, a Samsung 850 Evo 500GB SSD, a Samsung 850 Pro 2TB SSD, and a Be Quiet! Dark Rock Power Pro 1,200W PSU. All benchmarks were performed for their full duration, repeated three times for consistency, and the average calculated. Best scores are in bold type.

SPECIFICATIONS

	Chipset	Form Factor	Memory Support	Storage	PCIe x16	LAN	Price
ASRock Fatal1ty B150 Gaming K4/D3	B150	ATX	DDR3 1866	6x SATA 6Gb/s	2	1x Killer E2400 Gigabit	$100
MSI B150 Gaming M3	B150	ATX	DDR4 2133	6x SATA 6Gb/s, 1x SATAe, 1x M.2	2	1x Killer E2400 Gigabit	$110
MSI Z170A Tomahawk	Z170	ATX	DDR4 3600	6x SATA 6Gb/s, 2x M.2 PCIe	2	1x Realtek RTL8111H Gigabit	$150
Asus Z170i Pro Gaming	Z170	ITX	DDR4 4000	4x SATA 6Gb/s, 1x SATAe, 1x M.2 PCIe	1	1x Intel I219-V Gigabit	$165
Gigabyte GA-Z170X-Gaming 5	Z170	ATX	DDR4 3466	6x SATA 6Gb/s, 3x SATAe, 2x M.2 PCIe	3	1x Intel Gigabit, 1x Killer E2201 Gigabit	$167
MSI Z170A Gaming Pro Carbon	Z170	ATX	DDR4 3600	6x SATA 6Gb/s, 1x SATAe, 1x M.2 PCIe	3	1x Intel i219 Gigabit	$170
Gigabyte GA-Z170X-Gaming 7	Z170	ATX	DDR4 3866	6x SATA 6Gb/s, 3x SATAe, 2x M.2 PCIe	3	1x Intel Gigabit, 1x Killer E2400 Gigabit	$210
MSI Z170A Gaming M7	Z170	ATX	DDR4 3600	6x SATA 6Gb/s, 2x SATAe, 2x M.2 PCIe	3	1x Killer E2400 Gigabit	$220
Asus Maximus VIII Formula	Z170	ATX	DDR4 3733	6x SATA 6Gb/s, 2x SATAe, 1x M.2 PCIe, 1x U.2 PCIe	3	1x Intel I219-V Gigabit	$400
Asus Maximus VIII Extreme	Z170	EATX	DDR4 3866	6x SATA 6Gb/s, 2x SATAe, 1x M.2 PCIe, 1x U.2 PCIe	4	1x Intel I219-V Gigabit	$485

BENCHMARKS

	CineBench R15	Tech ARP x264 V5.0.1	Memory Bandwidth	AS SSD Sequential Read/Write	PC Mark Score	Maximum Overclock	CineBench R15 @ OC	Power Draw Idle/Peak
ASRock Fatal1ty B150 Gaming K4/D3	859	19fps	17GB/s	493/474MB/s	3,779	4.0GHz	859	**42**/297W
MSI B150 Gaming M3	874	19fps	26GB/s	**494**/473MB/s	3,978	4.0GHz	874	48/**288**W
MSI Z170A Tomahawk	922	**20fps**	27GB/s	491/475MB/s	**4,153**	4.9GHz	1,008	50/346W
Asus Z170i Pro Gaming	891	**20fps**	**30GB/s**	492/**477**MB/s	4,080	4.9GHz	1,058	48/297W
Gigabyte GA-Z170X-Gaming 5	915	**20fps**	26GB/s	**494**/472MB/s	3,907	4.9GHz	1,060	43/312W
MSI Z170A Gaming Pro Carbon	914	19fps	27GB/s	493/476MB/s	3,925	4.9GHz	**1,072**	51/296W
Gigabyte GA-Z170X-Gaming 7	918	19fps	26GB/s	493/471MB/s	4,073	4.9GHz	1,059	45/334W
MSI Z170A Gaming M7	923	**20fps**	**30GB/s**	**494**/476MB/s	4,028	4.9GHz	1,064	84/318W
Asus Maximus VIII Formula	**931**	**20fps**	**30GB/s**	493/476MB/s	4,004	4.9GHz	1,061	56/324W
Asus Maximus VIII Extreme	907	**20fps**	29GB/s	490/**477**MB/s	4,053	**4.95GHz**	1,035	56/355W



And the winner is...

Gigabyte GA-Z170X-Gaming 7

AS YOU CAN PROBABLY TELL by our extensive benchmarks table, the variance in performance between these mighty mobos was almost non-existent. Don't get us wrong—it's still there, and you can notice it in places, but at most it only ever amounted to 3 or 4 percent. In reality, you're just not going to notice a difference that small outside of benchmarking or particularly lengthy simulations, at which point, these kinds of motherboards just wouldn't even be considered.

So what are the criteria that really differentiate a winner from the rest here? Well, it's all down to feature set, ease of use, and style, with feature set being the more important of the three. After all, what use is a Z170 motherboard if you can't take advantage of all that the chipset has to offer, including the vast extension on the number of PCIe lanes available? For those reasons alone, and despite Gigabyte's often-cumbersome BIOS, the GA-Z170X-Gaming 7 came out as the winner.

BUILD ON SUCCESS

The overall look and feel of the board is outstanding. The rear I/O cover and intuitively integrated LED lighting work exceptionally well together. Couple that with a radical color scheme, and we're immediately out on top here. It's simply exceptional. We're a big fan of colorful builds here at *Maximum PC,* and these Gigabyte boards have some serious build potential.

But we get it—not everyone is interested in what your system will look like. A good proportion of you simply won't care about the LEDs dotted around that mobo. For those who are going to throw this straight into a windowless chassis, it's the feature set that really matters. Let's put it this way: In theory, you could run two M.2 PCIe NVMe drives in RAID 0 on this board, and two- or three-way SLI/Crossfire, and not even have to worry about it. On top of that, you have access to HDMI 2.0, USB 3.1 Type C, and dual Ethernet connectors, plus a fantastic audio solution. It's simply brilliant in pretty much every regard. OK, there's no U.2 slot on here, or one our favorites, the right-angled USB 3.0 header, but that's not enough for us to mark this one down a notch.

That said, there's still a lot of great motherboards in this group test, and a lot of value options for those looking to dip their toes into the Skylake water. MSI's Z170A Tomahawk, Gigabyte's GA-Z170X-Gaming 5, and Asus's Z170i Pro Gaming—all are fantastic offerings, designed to cater to different audiences, while still taking advantage of the Z170 chipset.

So what have we learnt from all of this? Well, price really doesn't dictate performance. For the vast majority of us, the CPU is going to be the biggest limiting factor. Those thermally stable VRM solutions and power phase designs will undoubtedly not matter for processors under the 5.5GHz mark, and as that's well above 95 percent of CPUs, your best bet is to pick a motherboard that is best accommodated by your build, boasts the features you want, and is one that you like the look of. Perhaps one day we'll see a motherboard that reaches beyond software suites and empowered audio solutions, and when that day comes, the benchmarks may matter again. ⏻

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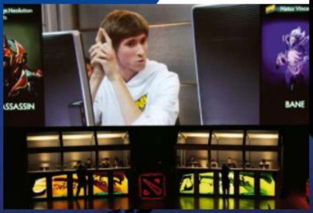

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MAKE WINDOWS AWESOME

Push Windows harder with 35 top tips

By Nick Peers

The hype has died down, the initial euphoria has evaporated, and we're left with a sense that Windows 10 isn't quite what it was cracked up to be. There's plenty of good stuff—particularly compared to Windows 8—but it feels as though Microsoft has dropped the ball in other areas: forcing updates down your throat, on the one hand, or taking major liberties with your privacy on the other, for example. The fact is, like all versions of Windows before it, Windows 10 has elements of good and bad. It's kinder on system resources, boasts improvements such as File Explorer, and contains evidence of Microsoft's biggest *volte-face* yet with the return of the Start menu.

What's more, if Windows 10 isn't quite the great leap forward Microsoft claimed it would be, there's plenty you can do to make things better. We've already shown you how to deal with its worst annoyances in our March 2016 issue, so we've dug even deeper to find tips and tricks to help push Windows 10 that little bit harder, while taking steps to rectify some of its worst offenses.

We start things off by looking at your core hardware and system, then move on to uncover some handy system tweaks. We then finish off by examining some more advanced tips that will help squeeze even more from your PC. We also reveal what to do if you plan to stay with Windows 7, examine whether Linux is a viable alternative to Windows 10, and reveal some of our best troubleshooting tips to help you in times of trouble.

The end result is a computer and operating system working more in harmony with each other. Oh, and you won't have to worry quite so much about whether or not Microsoft is snooping on you, either.

I'm Cortana. Ask me anything.

10

Dragon Mania Legends
Become the ultimate Dragon Lord
tripwolf - Your Travel Guide
Top apps
Top games
Featured
Collections
Show all
Picks for you
Most Popular
NETFLIX
Netflix
Owned
Candy Crush Soda Saga
Minecraft: Windows 10 Edition Beta
Facebook
Microsoft Solitaire Collection
Candy Crush Saga
Shooting Showdown
CropiPic - crop video & image
Six-Guns
Movie ShowTimes
Backgammon Intelligence
17:07
01/03/2016

HARDWARE & CORE SYSTEM

1

BYPASS MICROSOFT UPDATE

Microsoft Update may contain plenty of drivers, but they tend to be conservative in nature. You'll want to download graphics and chipset drivers direct from your manufacturer if any are provided, or you could take the lazy option and use a tool such as IObit Driver Booster Free (www.iobit.com) to automate the process for you, plus uncover updates for more obscure drivers. Just make sure you deselect the relevant option during setup to avoid installing the full Advanced SystemCare suite.

2

FIND OLDER DRIVERS

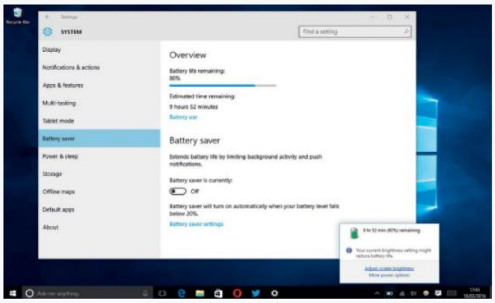
If you've got older hardware, you may find Windows 10 doesn't provide driver support. Don't panic, though—if you upgraded from an older version of Windows, your old drivers should work fine. If you've installed from scratch, you should get away with Windows 8, 7, or—at a push—Vista drivers, so long as they're the correct system type (32-bit or 64-bit).

» The biggest issue with older hardware occurs when making the jump from 32-bit to 64-bit, but you might be able to keep your old scanner going a bit longer if you're happy to shell out $30 for VueScan (www.hamrick.com). Also try sourcing generic PostScript or PCL drivers for laser printers that support either standard.

3

SET UP VIRTUAL DESKTOPS

One of Windows 10's best new features is that it adds native support for virtual desktops, making it easy to spread yourself across literally dozens of desktops if you wish. Click the "Task View" taskbar button, or press Windows-Tab to bring up the new Task Switcher, then click "New Desktop" to add a second desktop. You can then drag app thumbnails to the desired desktop, or right-click and choose "Move to" to select a specific desktop.



Overview

Battery life remaining:
80%

Estimated time remaining:
9 hours 52 minutes

Battery saver

Extends battery life by limiting background activity and push notifications.

Battery saver is currently:
Off

Battery saver will turn on automatically when your battery level falls below 20%.

Your current brightness setting might reduce battery life.

Get the Windows 7 battery icon back.

» Speed things up further by creating—and switching to—a new virtual desktop from your current one by using the Windows-Ctrl-D shortcut. Close the current desktop using Windows-Ctrl-F4, and move between desktops using—you guessed it—Windows-Ctrl-left or right arrow keys.

4

MASTER TOUCHPAD GESTURES

Got a touchpad? You'll find that there are some handy gestures you can master to speed up the way you navigate your laptop. Start by sliding two fingers vertically or horizontally to scroll the current window, then pinch in and out with the same fingers to zoom in and out.

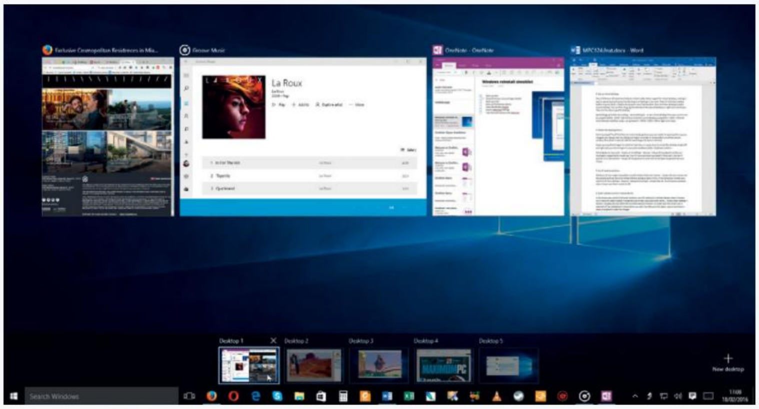
» Swipe up using three fingers to switch to Task View, or swipe down to reveal the desktop. Swipe left and right with your three fingers to access the traditional Alt-Tab task switcher.

» Not all gestures may work—head over to "Settings → Devices → Mouse & touchpad" to verify your touchpad is supported if they don't (it should say, "Your PC has a precision touchpad"). But don't assume it's a requirement; we got all the gestures to work with a touchpad recognized only as a mouse.

5

SCROLL INACTIVE WINDOWS

Windows 10 now makes it possible to scroll windows that aren't active—simply roll your mouse over the window and use the scroll wheel without having to select it first. If this behavior irritates you, switch it off from "Settings → Devices →



Windows 10 includes built-in support for multiple desktops—at last.

I'm Cortana. Ask me anything.

Mouse & touchpad”—simply flick the “Scroll inactive windows when I hover over them” switch to “Off.”

6

SCALE MULTIPLE MONITORS

In this brave, new world of ultra-HD monitors, one DPI setting for multiple displays doesn’t always cut it. Now the slider marked “Change the size of text, apps, and other items…” found under “Settings → System → Display” only affects the currently selected monitor, so make sure the correct one is selected (it’s highlighted in blue) before you alter the slider, and click “Apply.” Log out and back in when prompted to make the change.

7

FINE-TUNE YOUR HYBRID DEVICE

If you’ve bought a two-in-one tablet/laptop device, here are some neat tricks to try. First, bypass Continuum mode, whereby Windows 10 attempts to automatically switch to and from tablet mode, depending on when you’ve docked it to the keyboard. You can manually switch it via the Notification Center—tap “Tablet Mode” to do so. Tweak other tablet mode preferences via “Settings → System → Tablet mode,” where you can—among other things—keep the taskbar on screen at all times by changing “Hide app icons on the taskbar in tablet mode” to “Off.”

8

ACCESS HOTSPOTS SECURELY

There are serious privacy issues with Windows 10’s Wi-Fi Sense feature, but why not take advantage of the convenience offered without compromising security, by only connecting to open hotspots through the security of an encrypted VPN connection? If you’re willing to put up with throttled connection speeds and some delays in connecting, a free service such as CyberGhost (www.cyberghostvpn.com) should suffice for basic browsing and checking email, all while minimizing the risk of being snooped upon.

» Oh, and while we’re on the subject of Wi-Fi Sense, opt your home network out of it by adding “_optout” to the end of your Wi-Fi network’s SSID.

9

BATTERY SAVER

Windows 10’s new Battery Saver settings may not be to your taste, so fine-tune them with a trip to “Settings → System → Battery Saver.” Click “Battery saver settings” to change the point where Battery Saver kicks in (it’s 20 percent battery by default), plus configure which apps can continue to notify you even when it’s running.

» If you hate the new battery taskbar icon, restore the old one—edit the Registry by going to the “HKEY_LOCAL_MACHINE\Software\Microsoft\Windows\CurrentVersion\ImmersiveShell” key, and creating a new DWORD value “UseWin32BatteryFlyout” with the value of 1, or use Ultimate Windows Tweaker 4 (http://bit.ly/uwt-win10), go to “Customization → Windows 10,” and deselect “Use New Battery Flyout.”

CyberGhost
Protection enabled!
U.S.A - NewYork-S09-I01
CyberGhost 5.5 - Settings - 5.5.1.3
General
Privacy Control
My Account
Startup
Language
English
Default settings
Load/Save settings

Use a VPN if you plan to connect through open Wi-Fi hotspots.

10

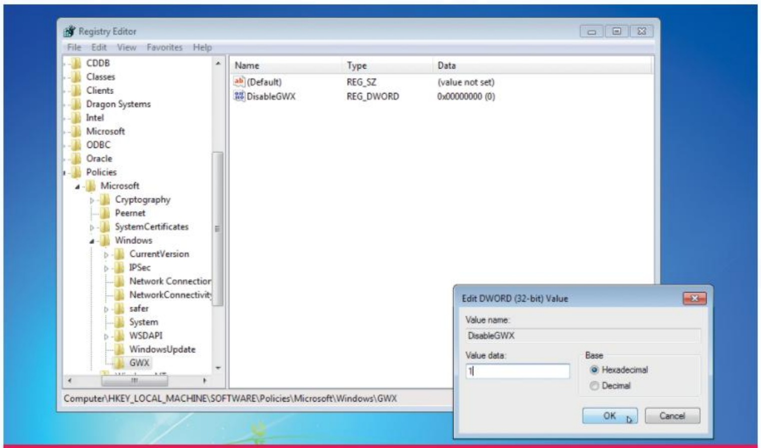
VIEW DRIVE USAGE

Wondering what’s taking up space on your hard drive? Browse to “Settings → System → Storage,” click on your target drive, and you’ll see a color-coded breakdown of what’s where. Click on a section to drill down for more detail.

11

SPEED UP CPU

Make sure your CPU always runs at maximum by pressing Windows-X to open the Quick Access menu. Select “Power Options” and switch to “High performance.” Or click “Change plan settings,” then “Change Advanced Power Settings → Processor power management → Minimum processor state” to set the figure to 100 percent manually.



Name	Type	Data
(Default)	REG_SZ	(value not set)
DisableGWX	REG_DWORD	0x00000000 (0)

Computer\HKEY_LOCAL_MACHINE\SOFTWARE\Policies\Microsoft\Windows\GWX

Value name: DisableGWX

Value data: 1

Base: ● Hexadecimal ○ Decimal

Disable the Windows 10 upgrade prompt via the Registry.

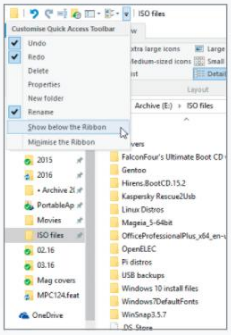
Sticking with Windows 7?

THERE MAY BE VERY GOOD REASONS why you’ve decided to turn your back on Windows 10. Your PC may not be compatible—even if the Windows upgrade tool tells you otherwise, check with your manufacturer first, and Google your PC model to see if others have had issues. You may simply be disinclined to upgrade because everything works, and you know Windows 7 inside out.

» On the other hand, Windows 7 is in its “extended support phase,” which means there’s no development or free support other than critical security hotfixes and patches, which will continue until January 14, 2020. There’s also the fact you can take a full drive image and upgrade for free before July 29, give Windows 10 a try, then revert if you don’t like it (the drive image is your fail-safe if “Settings → Update & Security → Recovery” doesn’t work).

» If you have no intention of upgrading, you can disable Microsoft’s annoying siren calls with two Registry tweaks. Go to “HKEY_LOCAL_MACHINE\SOFTWARE\Policies\Microsoft\Windows,” and create a WindowsUpdate key inside it, then create a DWORD value inside that called “DisableOSUpgrade,” and set it to 1. Navigate back to the “Windows” key and create a sub-key called “GWX,” inside which you create another DWORD value—“DisableGWX”—and set it to 1. Reboot, and the nags should be gone.

TWEAK YOUR SETTINGS



Place favorite ribbon commands on the Quick Access toolbar.

12

MAKE SETTINGS MORE ACCESSIBLE

Got a favorite tweak you frequently find yourself burrowing into Settings to find? You can create a one-click shortcut to it a number of different ways. First, you can pin it as a tile to the Start menu simply by locating it in Settings, then right-clicking its entry in the left-hand pane, and choosing "Pin to Start."

» It's also possible to launch individual settings directly from the "Start → Run" box, or create shortcuts to them on the desktop (right-click the desktop and choose "New → Shortcut"). The format is pretty consistent—for example, "ms-settings:display" opens the Display settings, while "ms-settings:network-wifi" goes straight to the Wi-Fi section of "Network & Internet." You'll find a full list at https://msdn.microsoft.com/mt228342.aspx.

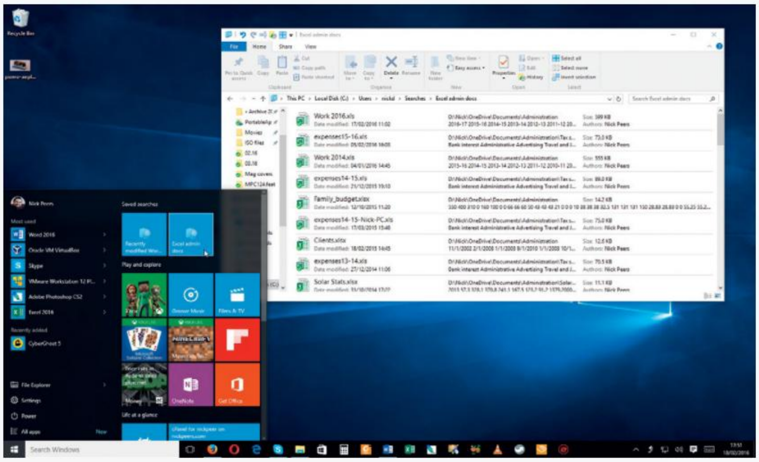
13

PIN SAVED SEARCHES TO START

File Explorer's search tool is a powerful beast—for example, you can set up a search to reveal all the recently modified Word documents in a specified folder or drive by browsing to that location in File Explorer, then typing "type:word datemodified:this week" into the Search box. Click "Save search," give it a suitably descriptive name ("Recently modified Word documents," for example), and click "Save" to add it to your Searches folder.

» If you then browse to your user folder and open Searches, you can access that search—but make it even more accessible simply by right-clicking it and choosing "Pin to Start."

Pin saved searches to the Start menu for quicker access.



14

TWEAK QUICK ACCESS SETTINGS

The Quick Access area now tries to juggle frequently and recently accessed folders with pinned folders of your choosing. Open File Explorer, switch to the "View" tab, and click "Options" to choose whether or not to display recent files and frequent folders here. You can also switch the starting point for all new File Explorer windows back to This PC from here, too, via the "Open File Explorer to" drop-down menu.

15

STREAMLINE NAVIGATION PANE

Too many items showing on the navigation pane? Browse to http://winaero.com/download.php?view.1796 to download the free Winaero Tweaker tool. Launch the app, and select "Default Items" under "Navigation Pane." Then simply deselect those items you don't want to see, such as "Homegroup" or "Removable Drives" (which show up under This PC anyway). Sign out and back in for the changes to take effect.

16

USE QUICK ACCESS TOOLBAR

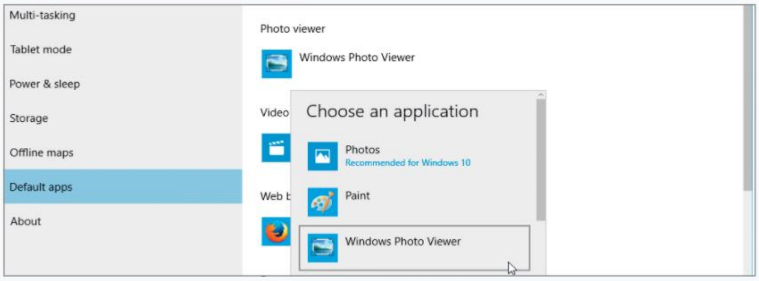
This isn't related to the Quick Access menu, but is a separate part of those windows with ribbons, such as File Explorer and Office. It enables you to place shortcuts to frequently used ribbon commands in a place you can get them. Just right-click the item in question, and choose "Add to Quick Access Toolbar." Up to seven items can be placed in the toolbar's default location before they disappear behind a ">>" button—if you click the down arrow next to the toolbar and choose "Show below the Ribbon," however, you can free up space to show dozens at once.

17

FORCE CORTANA TO USE GOOGLE

Cortana might be focussed on Bing tech, but that doesn't mean you have to put up with its choice of Bing when performing web searches. Make Firefox your default browser, and it automatically uses whichever search engine of choice you like.

» Sadly, that doesn't work for Chrome, but install the Chrometana extension, and you can choose an alternative from Google, Yahoo!, or DuckDuckGo. Opera users can also access Chrometana, but first you need to install the Download Chrome Extension add-on to open up access to the Chrome web store.



Make Windows Photo Viewer the default in Windows 10.

18

RESTRICT CORTANA SEARCH

By default, Cortana favors web results over locally stored content when using generic search terms. You have to click "My Stuff" to search locally. If you have no use for Cortana as a web search tool, disable it—open Cortana and click the notebook icon on the left before selecting "Settings." Flick the top switch to "Off," which reveals a new switch: "Search online and include web results." Flick this to "Off" and you'll see the search box now only says "Search Windows," confirming it's no longer interested in the web.

19

TIGHTEN PRIVACY

There are so many privacy holes in Windows 10, it can be difficult to know where to find them all. Make the process of locking down your PC that much easier by downloading and running O&O ShutUp! (www.oo-software.com/en/shutup10). This free portable tool offers a one-click "recommended settings," or you can manually configure which privacy settings to apply.

20

SWITCH ON ONEDRIVE FETCH

Windows 10 restores OneDrive Fetch, a setting that gives you remote access to all your PC's files, not just those in OneDrive. Enable it on your PC by right-clicking the OneDrive taskbar notification area icon, and choosing "Settings → Settings tab," then select "Let me use OneDrive to fetch any of my files on this PC." You can now log into OneDrive through any browser, click the "≡" button, and select your PC under "PCs." If it's switched on and connected, you'll have access to your entire filesystem.

21

LOOSEN ONEDRIVE AND OFFICE 365

OneDrive does its damnedest to tie itself tightly into Office 365, trying to force you to default to your online storage rather than the physical file that's residing on your computer. You can tame it with a number of tweaks. First of all, open OneDrive's settings as per the previous tip, then deselect "Use Office to work on files with other people at the same time." It's also worth tweaking Office's own settings: select the "File" tab, choose "Options → Save." Select "Don't show the Backstage when opening or saving files," deselect "Show additional places for saving," and finally, select "Save to Computer by default," before clicking "OK."

22

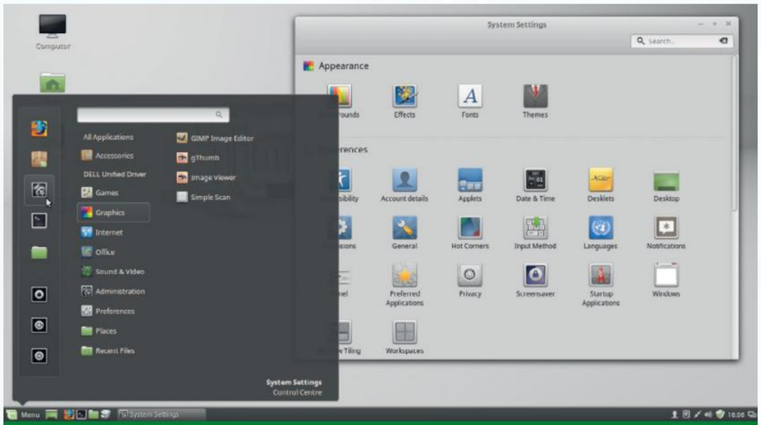
CHANGE DOWNLOAD FOLDER

It's possible to change the default download folder for Edge, but you'll have to delve deep into the Registry. Alternatively, use Winaero Tweaker again—scroll to the bottom of the available tweaks, where there's an easy way to switch the folder.

23

RESTORE PHOTO VIEWER EASILY

In issue 122, we showed you how to replace the awful Photos app with Windows Photo Viewer via a Registry tweak. If that's too much bother, fire up Ultimate Windows Tweaker again, switch to the "Additional" section, and click "Enable Windows Photo Viewer." You should now be able to make it the default under "Settings → System → Default apps."



Linux Mint provides a familiar desktop environment.

The Linux Alternative

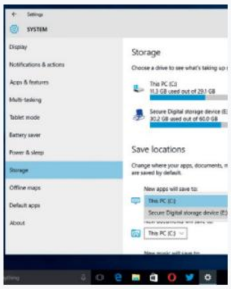
DON'T WANT TO STICK WITH WINDOWS 7, but reluctant to twist with Windows 10? Why not take the plunge and make the switch to Linux instead? These days, the likes of Ubuntu—and one particularly flavorsome derivative called Mint—are making a renewed grab for power users.

The jump from Windows isn't as big as it used to be either—yes, there's a learning curve, but it's not insurmountable, and you can avoid the Terminal for the most part, too. If you're a gamer, you'll even find the lack of overheads in Linux help boost performance, too, and with platforms such as Steam now available on Linux, the choice for gamers is widening all the time.

That said, while hardware and software support is improving, there's a long way to go. Well-known suites such as Office and Photoshop aren't directly supported; although tools such as PlayOn Linux and Wine help get some Windows software running, there are free, open-source alternatives to most apps. You may also have trouble getting certain hardware working—check the manufacturer's website for native Linux apps, or Google the product name and "Linux" to see whether open-source drivers exist.

If you're thinking of switching, either try Linux out in a virtual environment using VirtualBox, or take a full system backup and install it alongside Windows, giving you the chance to migrate from one platform to the other.

ADVANCED TIPS AND TRICKS


Settings
SYSTEM
Display
Notifications & actions
Apps & features
Multi-tasking
Tablet mode
Battery saver
Power & sleep
Storage
Offline maps
Default apps
About
Storage
Choose a drive to see what's taking up
This PC (C:)
11.3 GB used out of 29.1 GB
Secure Digital storage device (E:)
30.2 GB used out of 60.0 GB
Save locations
Change where your apps, documents,
are saved by default.
New apps will save to:
This PC (C:)
Secure Digital storage device (E:)
This PC (C:)

Windows 10 enables you to move apps to another drive.

24

RE-ROUTE APPS

If you're running out of space on your hard drive—or have a tablet with limited onboard storage—this next tweak enables you to instruct Windows 10 to install apps on another drive. Just navigate to "Settings → System → Storage," and scroll down to the "Save locations" section. Click the drop-down menu under "New apps will save to," and select your target drive.

›› You can also move some (but not all) existing Windows Store apps, too, if space is particularly tight—switch to "Apps & features," then click the app you'd like to transfer. If "Move" isn't grayed out, click it, select your destination, and click "Move" again.

25

ADD TABS TO FILE EXPLORER

File Explorer in Windows 10 is a huge improvement over Windows 7—there, we've said it. But it's still lacking in one key area: no tabbed support to prevent you cluttering up your desktop with multiple windows. Clover 3 is a free extension that basically adds Chrome-like tabs to File Explorer—get it from www.ejie.me.

26

CUSTOM START MENU FOLDER

Want to create your own folder in the "All Apps" section of the Start menu? Click "Start → Run," type "%appdata%" and hit Enter, then browse to "Microsoft\Windows\Start Menu\Programs." Create your custom folder inside here, then copy or move shortcuts to programs and apps from other folders to put them in one convenient spot.

27

CREATE THE GODMODE FOLDER

Right-click on the desktop and choose "New → Folder." Now enter the following, substituting "GodMode" with whatever descriptive term you like: "GodMode.{ED7BA470-8E54-465E-825C-99712043E01C}"

›› This provides you with a convenient one-stop shop for every Control Panel applet and option on your PC, complete with a search tool for super-fast access. Why not copy it to your new Start menu folder, pin it to the taskbar, or add it to the Windows Quick Access menu that appears when you press Windows-X?

›› To do the latter, you need to employ the services of Win+X Menu Editor (http://winaero.com/download.php?view.21). You can also—with the help of Ultimate Windows Tweaker—place a shortcut in the desktop context menu (select "All Tasks (God Mode)" under "Context Menu → Desktop Context Menu").

28

FREE UP DRIVE SPACE

Just upgraded to Windows 10? Have no plans to roll back? Free up gigabytes of drive space by opening File Explorer and verifying the existence of the "Windows.old" folder in drive C. Now, right-click your C drive and choose "Properties." Click "Disk Clean-up," wait for it to scan, and then click "Clean up system files." Select the "Previous Windows installation(s)" entry.

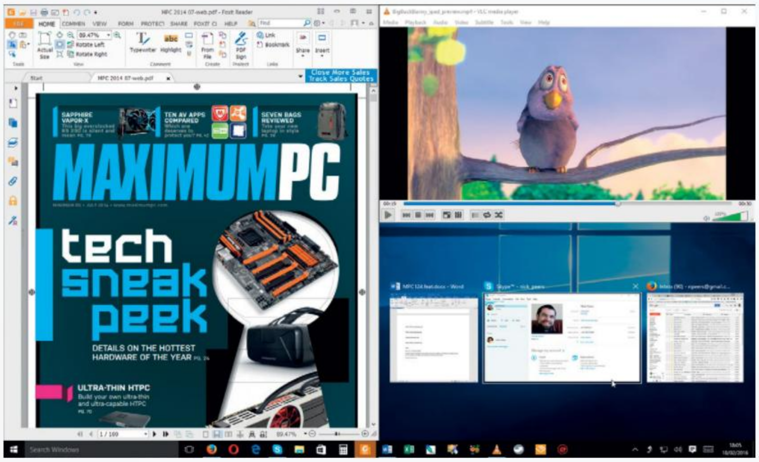
29

RECORD APP ACTIONS

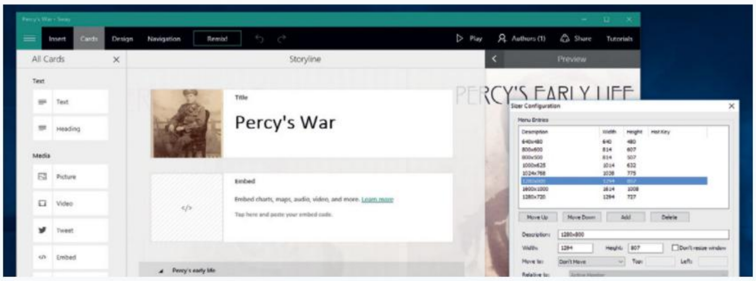
It's well known that Windows 10's Game DVR function works across any Windows Store app—press Windows-G when inside your target app, and click "Yes, this is a game" when prompted. If you plan to share your video with others, it makes sense to set it to the correct aspect ratio: 16:9 or 16:10 is usually best.

›› Doing this by hand is tricky, but use the free Sizer app (www.brianapps.net—choose the beta of Sizer 3.4) to quickly resize any app or program window with a handy right-click in its bottom right-hand corner. Choose "New Entry" to set up your custom size—owing to changes in Windows, make sure the actual width is 14 pixels wider than you want it to be, while the length must be seven pixels longer (for example, 1280x800 should be entered as 1294x807).

Snap up to four program windows in place.


MAXIMUMPC
tech sneak peek
DETAILS ON THE HOTTEST HARDWARE OF THE YEAR
ULTRA-THIN HTPC

I'm Cortana. Ask me anything.



Resize windows precisely with just two clicks.

30

UNLOCK CLIPBOARD SHORTCUTS

Windows 10 adds support for using Ctrl-C and Ctrl-V to copy and paste commands to and from the Command Prompt, but it's not always enabled by default. Switch it on by opening a Command Prompt window, then right-click the toolbar, choose "Defaults," and select "Enable Ctrl key shortcuts."

31

PUT UPDATE IN ITS PLACE

Fed up with Windows Update forcing updates down your throat? Windows 10 Pro users get the best deal—you can revert to the "notify me" approach: type "gpedit" into the Search box, and click "Edit group policy." Expand "Administrative Templates → Windows Components" under "Computer Configuration," and select "Windows Update." Click "Configure Automatic Updates" on the right, select "Enabled," then select option 2 or 3 to choose when to install updates after being notified. Click "OK."

32

REGISTRY QUICK SWITCH

Here's a handy tip when browsing the Registry. Many entries are duplicated between "HKEY_CURRENT_USER" and "HKEY_LOCAL_MACHINE" hives, and if there's a corresponding entry in the other hive, you can jump to it by right-clicking the key, and choosing "Go to." Perfect if you've drilled down into the Registry only to find you picked the wrong hive.

33

EXPAND THE SEND TO MENU

Hold Shift as you right-click an item, choose "Send To," and you'll reveal a cavalcade of additional options, mostly pointing to personal user folders. Manage Send To items via its own shell folder (type "shell:sendto" into the "Run" dialog box), or use Send To Toys (www.gabrieleponti.com/software) to add more useful entries, such as transferring files or filenames to the clipboard, or an option to manually select the folder you wish to send the item to.

34

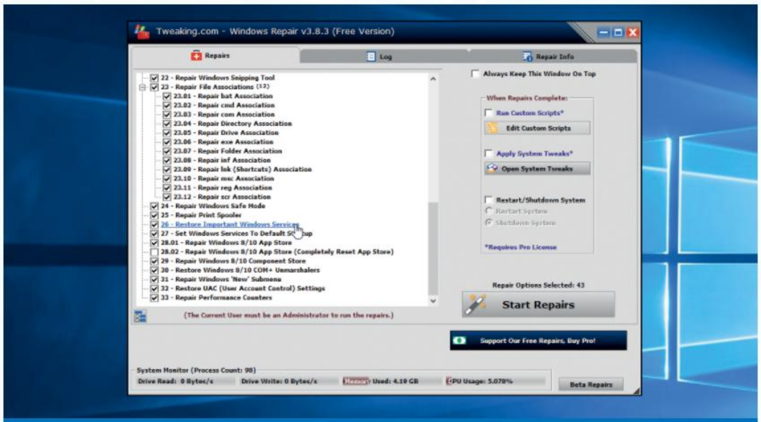
SNAP ASSIST

Windows 10's Snap Assist function extends the previous snapping capabilities—placing two windows side by side by dragging them to either side of the screen—to support three or four windows. Four windows can be dragged to opposite corners to take up a quarter of the screen space each, or you can combine the effect to place three windows together—two taking up a quarter of the screen, and the third taking up half. Fine-tune how this feature works by visiting "Settings → System → Multitasking," and experimenting with the switches.

35

ENCRYPT YOUR FILES—TWICE

Worried about the FBI's attempts to get hold of data on your phone? The simplest way to protect data in the cloud is to add a second layer of encryption before you upload it to OneDrive (or whatever service you use). Viivo (https://viivo.com) offers a free-for-personal-use package that enables you to keep your most sensitive files away from prying eyes, while integrating neatly into Windows and your cloud provider to make it simple to use. Pair it with the Viivo mobile app for access on the road. ⏻


Tweaking.com - Windows Repair v3.8.3 (Free Version)
Repairs
Log
Repair Info
Edit Custom Scripts
Open System Tweaks
Start Repairs
Support Our Free Repairs, Buy Pro!
Beta Repairs

- ☑ 22 - Repair Windows Snipping Tool
- ☑ 23 - Repair File Associations (12)
  - ☑ 23.01 - Repair bat Association
  - ☑ 23.02 - Repair cmd Association
  - ☑ 23.03 - Repair com Association
  - ☑ 23.04 - Repair Directory Association
  - ☑ 23.05 - Repair Drive Association
  - ☑ 23.06 - Repair exe Association
  - ☑ 23.07 - Repair Folder Association
  - ☑ 23.08 - Repair inf Association
  - ☑ 23.09 - Repair lnk (Shortcuts) Association
  - ☑ 23.10 - Repair msc Association
  - ☑ 23.11 - Repair reg Association
  - ☑ 23.12 - Repair scr Association
- ☑ 24 - Repair Windows Safe Mode
- ☑ 25 - Repair Print Spooler
- ☑ 26 - Restore Important Windows Services
- ☑ 27 - Set Windows Services To Default Startup
- ☑ 28.01 - Repair Windows 8/10 App Store
- ☐ 28.02 - Repair Windows 8/10 App Store (Completely Reset App Store)
- ☑ 29 - Repair Windows 8/10 Component Store
- ☑ 30 - Restore Windows 8/10 COM+ Unmarshalers
- ☑ 31 - Repair Windows 'New' Submenu
- ☑ 32 - Restore UAC (User Account Control) Settings
- ☑ 33 - Repair Performance Counters

(The Current User must be an Administrator to run the repairs.)

☐ Always Keep This Window On Top

When Repairs Complete:
☐ Run Custom Scripts*
☐ Apply System Tweaks*
☐ Restart/Shutdown System
○ Restart System
● Shutdown System
*Requires Pro License

Repair Options Selected: 43

System Monitor (Process Count: 98)
Drive Read: 0 Bytes/s
Drive Write: 0 Bytes/s
Memory Used: 4.19 GB
CPU Usage: 5.078%

Windows Repair Tool is an essential troubleshooting aid.

Fix Windows 10 problems

AVOIDING PROBLEMS IN WINDOWS is easier than dealing with them. This is where regular backups come into their own—Windows 10 includes Windows 7's Backup tool and Windows 8's File History, giving you the best of all worlds, although we also recommend Macrium Reflect Free (www.macrium.com/reflectfree.aspx) for taking full system images.

Make sure System Restore is switched on via the System Control Panel (type "restore" into the Cortana search box, then click "Create a Restore point"). If you upgraded through Windows, create a system recovery drive (type "recovery" into the search box) to give you access to recovery options when Windows won't boot.

We also recommend the Windows Repair Tool from www.tweaking.com—this contains one-click fixes and system tests that can resolve many issues, from permission glitches to problems accessing the Windows Store.

If you go to "Settings → Update & Security → Recovery," you'll find a "Reset this PC" option for major issues—you can keep your files, but no apps or settings. If you'd rather perform a repair install, you need the Media Creation Tool—follow the steps to "upgrade" to Windows 10, which installs Windows over the top of itself, fixing many problems without losing all your carefully curated programs, apps, settings, and files in the process.

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OPTIMIZE GAMING GRAPHICS

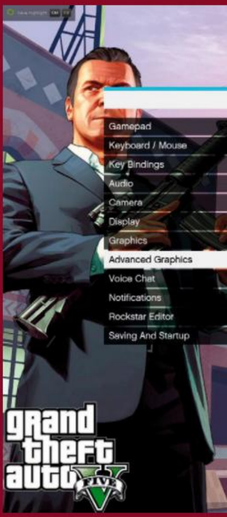
You want beautiful graphics and smooth frame rates? Immerse yourself in the wonders of your games' graphics settings. *By the Maximum PC team*

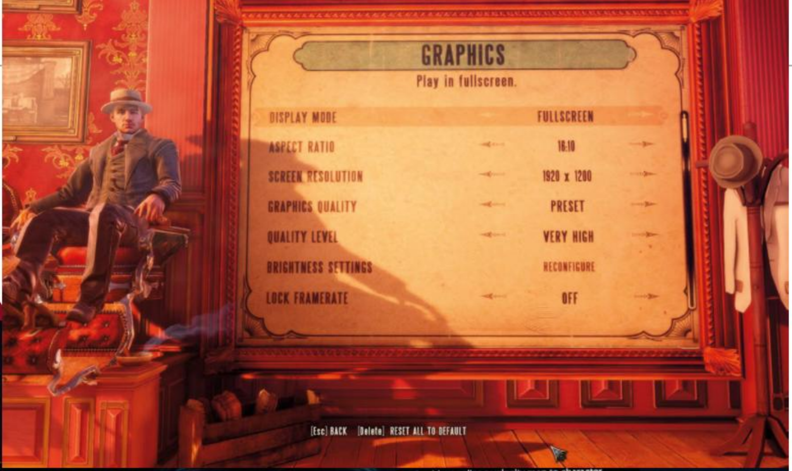
We all want the best. Of both worlds, if possible. For games, we want eye-searingly beautiful graphics, and we want them at silky-smooth frame rates. If you're lucky enough to have the very best and latest hardware, you should be able to play the latest and greatest games at the highest settings available. For the vast majority, though, some tinkering is needed to hit those smooth frame rates, and that's where this handy guide comes in. Over the next few pages, we'll pull apart all of the settings you're likely see in games, and tell you which ones are going to have the biggest impact on your frame rate counter.

Speaking of which, while it's good to go with your gut feeling about how smooth a game is, we recommend grabbing a third-party tool to show frame rates in game, so you can see whether your tweaking has had any real effect. We've traditionally used FRAPS for this, but have recently switched over to MSI Afterburner (http://gaming.msi.com/features/afterburner). You don't need an MSI card to use it, and it's free to download, so win-win all around, really.

While we're on the subject of software, one option worth pursuing is using Nvidia's and AMD's own tools to try to optimize your games for you. While these are by no means foolproof, they can do a good job of taking the pain out of the process—particularly on laptops. Nvidia's GeForce Experience relies on a huge database of settings and configurations to get the setup right, while AMD's Gaming Evolved utility provides a similar function by calling upon the gaming community to provide feedback on settings (which is why some games have no suggestions for optimization). Even if you intend to tweak your game settings yourself, these often make for a good, if crude, starting point for your experiments.

One last point: It's worth noting that not all settings are called the same things across all games. We've picked the most common names, but don't be surprised if you see some of these settings called something wacky in game. Right, on to the tweaking.





GRAPHICS

Play in fullscreen.

DISPLAY MODE FULLSCREEN

ASPECT RATIO 16:10

SCREEN RESOLUTION 1920 x 1200

GRAPHICS QUALITY PRESET

QUALITY LEVEL VERY HIGH

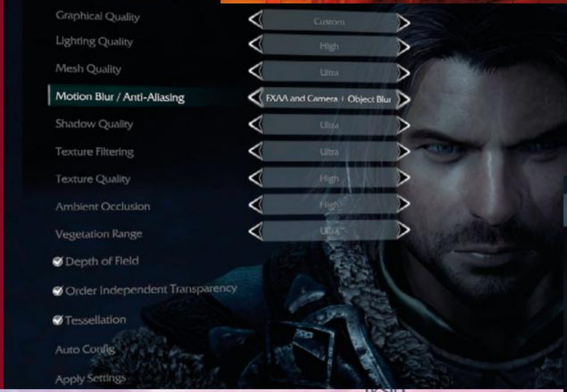
BRIGHTNESS SETTINGS RECONFIGURE

LOCK FRAMERATE OFF

Exclusive Full-Screen

This toggle controls the type of full-screen mode. When set to "On," the game fills the screen, and an Alt-Tab takes you to the desktop, with the game minimized. This is what you're probably used to in most games, and what we recommend using for most people. When set to "Off," the game renders in a borderless window to match the full-screen resolution that has been set. If you're wondering why this wasn't combined with the Full-Screen option, we are, too.

Running a game in a borderless window may sound funny, but it has its merits. The game gets rendered like any other window, and captures input when active. When you press Alt-Tab, you can drag other windows on top of the game, which may be useful if you're looking up guides (you cheat), or want to hop into another application quickly.



Advanced Options

Graphical Quality Custom

Lighting Quality High

Mesh Quality Ultra

Motion Blur / Anti-Aliasing FXAA and Camera + Object Blur

Shadow Quality Ultra

Texture Filtering Ultra

Texture Quality High

Ambient Occlusion High

Vegetation Range Ultra

☑ Depth of Field

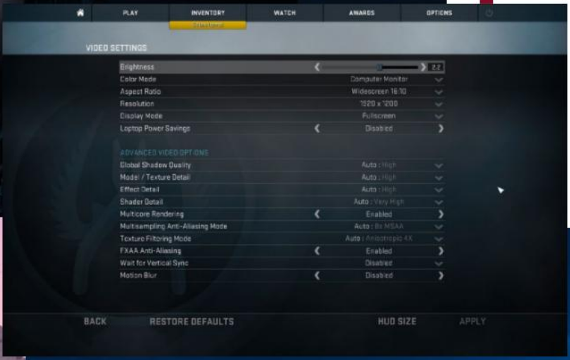
☑ Order Independent Transparency

☑ Tessellation

motion blur applies a velocity map to character models as well allowing legs and arms to blur as they move and will reduce over-blur.

Enabling Camera Motion Blur requires more graphical processing power. Enabling Camera + Object Motion Blur requires even more graphical processing power and can also have an effect on CPU performance.

Motion blur is dependent on frame rate. The lower the frame rate the greater the blur.



VIDEO SETTINGS

Brightness 2.2

Color Mode Computer Monitor

Aspect Ratio Widescreen 16:10

Resolution 1920 x 1200

Display Mode Fullscreen

Laptop Power Savings Disabled

ADVANCED VIDEO OPTIONS

Global Shadow Quality Auto : High

Model / Texture Detail Auto : High

Effect Detail Auto : High

Shader Detail Auto : Very High

Multicore Rendering Enabled

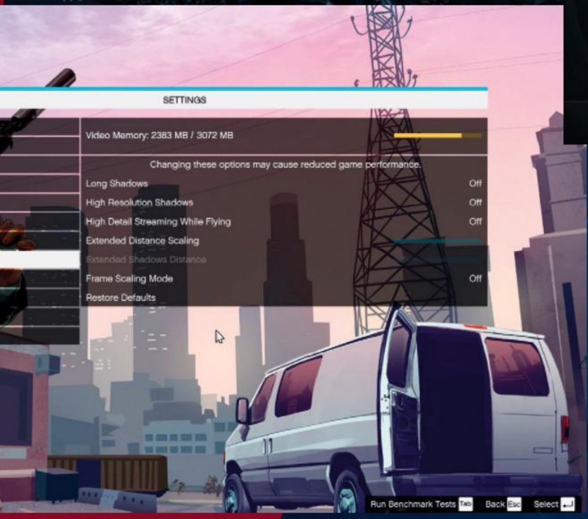
Multisampling Anti-Aliasing Mode Auto : 8x MSAA

Texture Filtering Mode Auto : Anisotropic 4X

FXAA Anti-Aliasing Enabled

Wait for Vertical Sync Disabled

Motion Blur Disabled



SETTINGS

Video Memory: 2383 MB / 3072 MB

Changing these options may cause reduced game performance.

Long Shadows Off

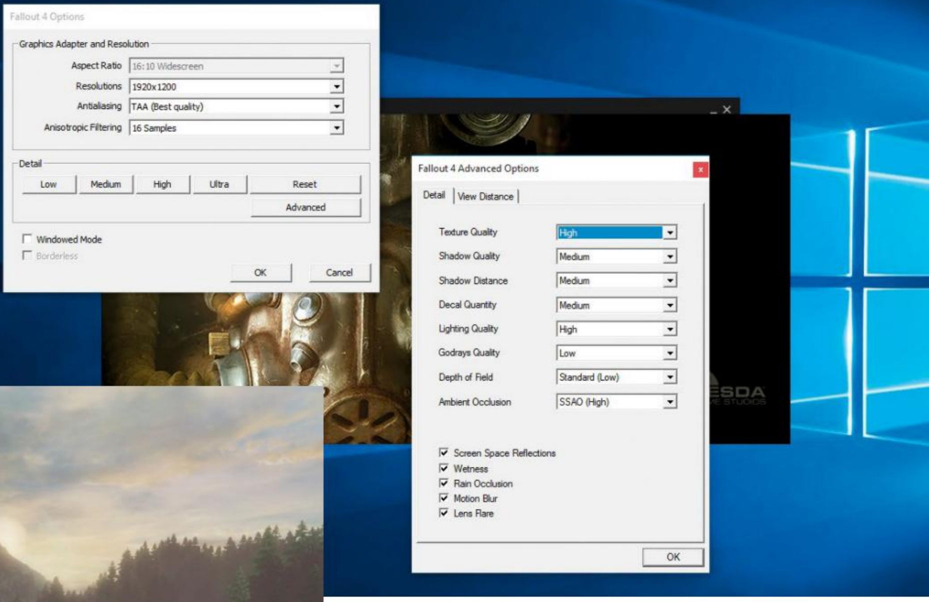
High Resolution Shadows Off

High Detail Streaming While Flying Off

Extended Distance Scaling

Extended Shadows Distance

Frame Scaling Mode Off



Fallout 4 Options

Graphics Adapter and Resolution

Aspect Ratio 16:10 Widescreen

Resolutions 1920x1200

Antialiasing TAA (Best quality)

Anisotropic Filtering 16 Samples

☐ Windowed Mode

☐ Borderless

Fallout 4 Advanced Options

Texture Quality High

Shadow Quality Medium

Shadow Distance Medium

Decal Quantity Medium

Lighting Quality High

Godrays Quality Low

Depth of Field Standard (Low)

Ambient Occlusion SSAO (High)

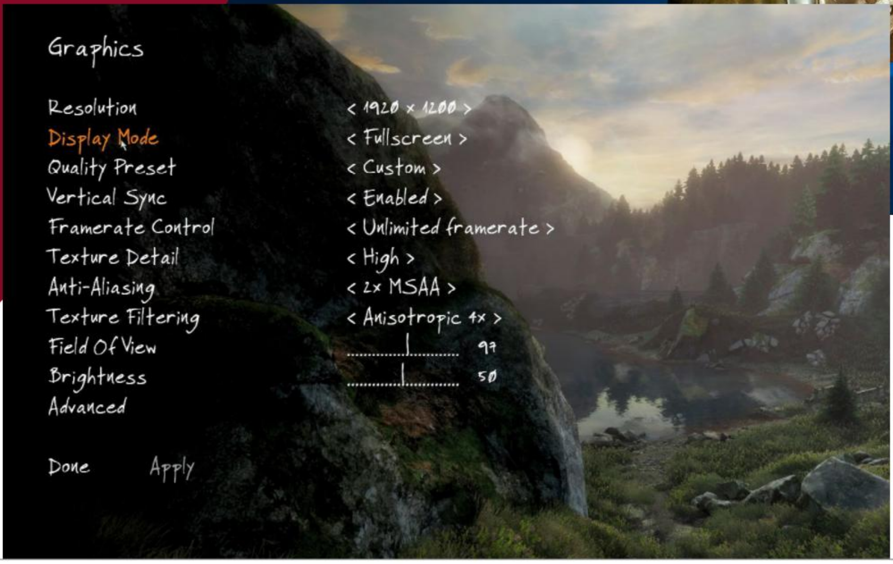
☑ Screen Space Reflections

☑ Wetness

☑ Rain Occlusion

☑ Motion Blur

☑ Lens Flare



Graphics

Resolution < 1920 x 1200 >

Display Mode < Fullscreen >

Quality Preset < Custom >

Vertical Sync < Enabled >

Framerate Control < Unlimited framerate >

Texture Detail < High >

Anti-Aliasing < 2x MSAA >

Texture Filtering < Anisotropic 4x >

Field Of View 97

Brightness 50

Advanced

Full-Screen

Most games enable you to determine whether the game will be played full-screen ("On") or in a window ("Off"). Generally, you'll want to play in Full-Screen mode, although those with multiple screen setups may have more fun with Window mode and some cunning window placement.

Resolution

When you set the resolution, you're setting the size of the rectangle that the game will render. This should default to your monitor's native resolution, but you can generally change it to any smaller resolution your monitor can display.

Changing the screen resolution is often the single biggest determiner of performance for your GPU. The larger the resolution, the more pixels that have to be calculated and rendered. If you can't get a decent frame rate at your native resolution with settings turned down, you can often get a higher frame rate by stepping down to a lower resolution and turning the other settings up a notch.

Running a game (or even Windows) at anything other than your screen's default resolution isn't ideal. Scaling to different resolutions isn't easy, and you'll see strange artifacts unless the render resolution is an obvious reduction of the native resolution. For example, running a 4K display at 1920x1080 is fine, as that doubles the size of the pixels. Running a 1080p panel at 1,024, however, will produce odd images.

Refresh Rate

The refresh rate should match one of the refresh rates available to your monitor. This allows VSync to work correctly. If you're not planning on using VSync (though you should probably be using VSync) you can sort of ignore this setting, but you should still set it to your highest possible refresh rate. (Hint: 24Hz without VSync results in even more tearing. Fun!)

VSync

Vertical-sync, or VSync, is a frame rate cap that the game or video driver places on the GPU. At first, VSync may sound counter-intuitive: Why the hell would you ever want to limit the output of your video card? Well, there are two big reasons.

First, VSync helps to synchronize the frame rate output with the refresh rate of your monitor. Without VSync, you can get what's called tearing, a nasty, glitchy-looking effect. In short, the screen output can contain portions of multiple frames, and when a lot of things change between frames, you get a horizontal split that's very visible. VSync causes frame buffer updates to only occur when the screen output isn't updating, eliminating tearing.

VSync can also improve stability and reduce heat. Without a frame rate cap to meet, your system happily churns out as many frames as it can. This requires the full effort of the GPU and CPU, meaning more heat and potentially a shorter product lifespan. Using VSync helps keep heat and GPU use under control. It can also smooth out gameplay, as a steady 60fps or even 30fps can often feel better than jumps from 60 to 200fps, and back.

The problem with VSync is that if your system is running just below your monitor's refresh rate—say, at 55fps on a 60Hz display—the next frame update always arrives after the screen update. On a 60Hz display, you end up running at a steady 30fps instead of 55fps, which some find too slow. If you're in an area that fluctuates between 55 and 65fps, it's potentially even worse, as you experience a stuttering effect, where a few frames update at 60fps, then you get some at 30fps, then back to 60.... But tearing isn't any better, which is why it's best to leave VSync on (unless you're benchmarking).

There is now technology to take care of the VSync problem. AMD's FreeSync and Nvidia's G-Sync allow your GPU and display to synchronize updates within a supported refresh range. So if your GPU runs at 50fps, your display refreshes at 50Hz. It can really improve the gaming experience, particularly if you're falling shy of the "magical" 60fps mark. The only problem is cost—FreeSync and G-Sync displays cost more than regular ones.

Tesselation

Tesselation is a fancy word that describes the subdivision of polygons into smaller polygons. Wait—what?

Three-dimensional objects in games are first rendered by drawing polygons, which are then covered with a texture. The fewer the polygons in an object, the more blocky it looks (think of a cube). The more polygons (or sides) you add to the object, the more round or defined its characteristics can be (think of going from a dodecahedron to a sphere). Tesselation is basically a way to use texture to take a flat object and add depth, by creating a bunch of additional polygons. It looks great, but it takes a bunch of computing power to do it. In graphics engines, tesselation is usually only done fairly close to the player (or "camera"), because there's no need to display details the player won't notice.

Antialiasing

Antialiasing is one of those settings that has a drastic effect on the appearance of a game. To put it simply, antialiasing is a type of edge blurring that attempts to make the transition between two adjacent, contrasting colors easier. This helps eliminate aliased edges, or "jaggies." If you've ever used Photoshop to zoom in on an image, and noticed how an outline or edge looks jagged, antialiasing is the equivalent of using the blur tool to make those edges a little softer.

After the screen resolution, antialiasing is frequently the next most "expensive" option to use. On top of that, the higher the resolution, the more expensive antialiasing becomes. However, there's a limit to its usefulness: Antialiasing is typically used to compensate for low pixel density screens. With a high enough pixel density, the effects of antialiasing become harder to notice. If you use a moderately sized 4K monitor (as opposed to a 40-inch monster), the physical pixels are smaller. That increased definition and accuracy often lets you do away with antialiasing, which results in some pretty big compute savings for the GPU. This doesn't work as well at 1440p or 1080p, so if you're gaming at those resolutions, it's a very good idea to turn on antialiasing.

There are several antialiasing modes available these days, and despite what we just said, the impact on frame rates ranges from mild to severe. Not all modes are available in all games, but here are the major ones:

FXAA (*Fast approXimate AntiAliasing*) will usually work just fine in most cases, and it's a type of post-processing—a smart blur filter applied to the final rendered output before it gets sent to the screen. It's very fast on modern GPUs, and is practically free to enable, though it doesn't always eliminate all jaggies.

SMAA (*Subpixel Morphological AntiAliasing*) is another post-processing filter, but it's supposed to look better than FXAA, with a similar performance hit. In testing, we've found SMAA tends to run slightly slower than FXAA.

SSAA (*Super-Sample AntiAliasing*) is one of the best-looking forms of antialiasing, but it's also by far the most demanding. It effectively renders the game at a higher resolution (2x or 4x your selected resolution), then samples that down to your native resolution. Unless you have an extremely beefy setup, you're likely to want to avoid SSAA and invest the computing power elsewhere.

TAA (*Temporal AntiAliasing*), as the name suggests, is concerned with dealing with aliasing that appears due to objects moving in a scene. It essentially renders more frames than are displayed, smoothing the movement of objects that are moving significantly faster than the camera's effective frame rate. This AA mode can be found in Bethesda's *Fallout 4* and *Skyrim*.

Anisotropic Filter

Anisotropic filtering helps to make sure textures don't look weird when viewed on surfaces that are closer to parallel with the user's gaze than perpendicular. The higher the setting, the better textures look when not viewed straight-on. It also blends the transition between mipmaps (different texture resolutions are used based on how far a texture is from the user; there's no need to use a 2K texture on an object that's so far away that it only fills a few hundred pixels).

While it used to be quite expensive, modern GPUs are adept at anisotropic filtering, though dropping it down to 2x may give you a couple of extra fps. We don't recommend dropping it down to trilinear, as anisotropic looks far better.

Ambient Occlusion

If the objects in a game were like the contours of an object in a sketch, ambient occlusion is like the shading an artist would use to bring out the details. Ambient occlusion helps accentuate the contours of just about every object in the game, to create a better sense of depth. We highly recommend leaving this switched on. The game just doesn't look as impressive without it. If you've got a dozen extra frames to spend on quality, switching this setting to HBAO+ (Horizon Based Ambient Occlusion) yields even better results. This setting is computationally expensive, though, so we recommend leaving it switched off, unless you've got some serious graphics muscle to help kick it up a notch.

Depth of Field

If you've never taken a photography course, the idea of depth of field may be a little foreign to you. Don't worry—it's an easy enough idea to wrap your head around.

Depth of field has to do with the focal plane of a lens. A lens can only focus to a given distance. Depth of field determines how far away objects can be from that plane while staying in focus. A large depth of field means almost everything is in focus (like a landscape photo), while a narrow depth of field makes everything in front of or beyond the plane look blurry (think of a close-up of a flower).

This setting determines how much processing is allocated to creating a depth-of-field lens effect. For some, it may not matter, because the effect is often subtle. However, the setting does add a little polish to the way the game feels, so we recommend leaving this set to "On," unless you're really pressed for frames—and even then, the difference in performance is generally not very big.

Texture Quality

The texture quality sets the size of the texture files that your game uses to skin the game models. Simply put, the higher the setting, the larger the resolution of the texture files, and the more graphics memory you need to hold those textures. There's a lot of processing that goes on with textures as well, so a higher setting also taxes the GPU more.

This is a setting that's often worth experimenting with if you're not getting smooth performance, as slightly lower than maximum settings still tend to look good. Conversely, if you're running a high-resolution display, you'll find yourself wanting the highest-resolution textures—even searching out third-party mods, if necessary.

Mesh Quality

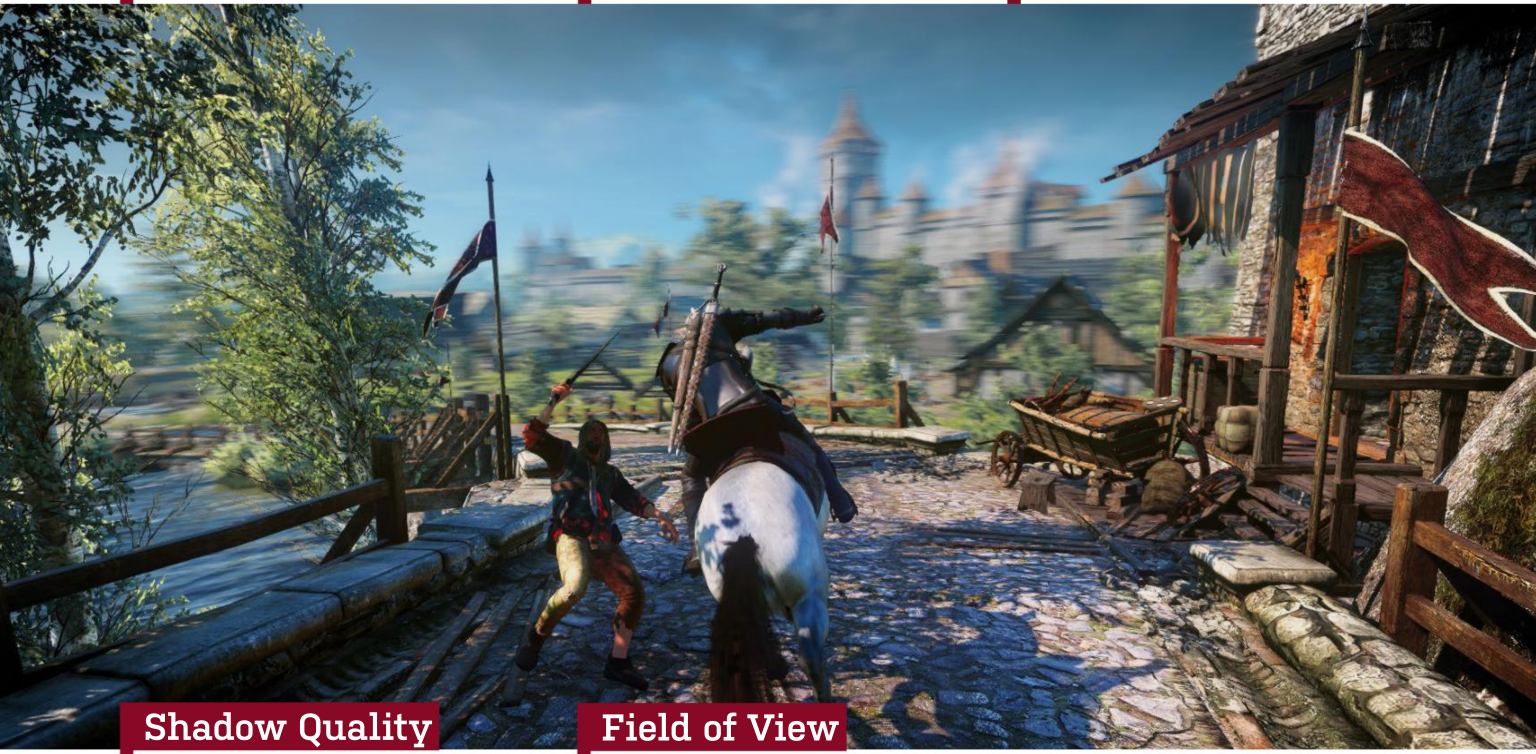
Mesh quality affects how models look. The higher the mesh quality, the more details (and polygons) models have. The things you'll likely notice most are the tesselations and draw distance. We like to keep this setting cranked up to "High" or" Ultra."

Motion Blur

Motion blur helps give the illusion of speed by blurring objects to reflect motion. We like to keep it enabled, but if you're really trying to eke out a few extra frames, it's one more effect that's more like icing on the cake.

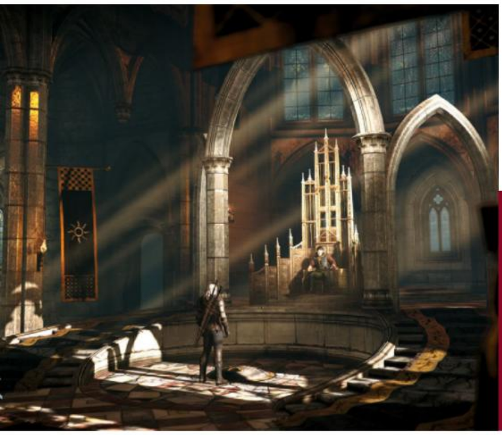
Level of Detail

This sounds like a very vague setting, but it's actually an important one. It controls the number, draw distance, and quality of object meshes in the game. Higher settings require more processing power and memory, while lower settings can create good savings in terms of compute power.



Shadow Quality

This setting controls how sharp shadows appear in game. The lower the setting, the more "jaggies" you see in shadow effects. We don't recommend turning it to "Off," as it often ruins the atmosphere of the game. The difference in performance is generally not very big.



Field of View

The field of view affects, well, the field of view of the screen. If present in the interface (and not hidden away in an INI file somewhere), this option tends to range from 40 up to 109 degrees, and in most games defaults to 55. Unless you're using an ultrawide monitor, we generally recommend leaving this alone. However, some players prefer wider fields of view, enabling them to see more of the battlefield. Using a wider field of view does make the player models for the hands and weapons appear skinnier, though.

Bloom

Bloom enables the bloom effect when moving from dark to light areas, like that painful contrast between sitting in a dark room and walking out into a bright, sunny day that makes you wonder if you're part vampire. You can take it or leave it, but it won't destroy your frame rate to leave it on.

Lens Flare

This option should be pretty obvious. If you're reminded of Michael Bay every time you see a lens flare, feel free to turn this one off. If you like your lenses to refract light when pointed directly at a light source, though, you should leave it turned on. It's not terribly expensive in most scenes. ⏻

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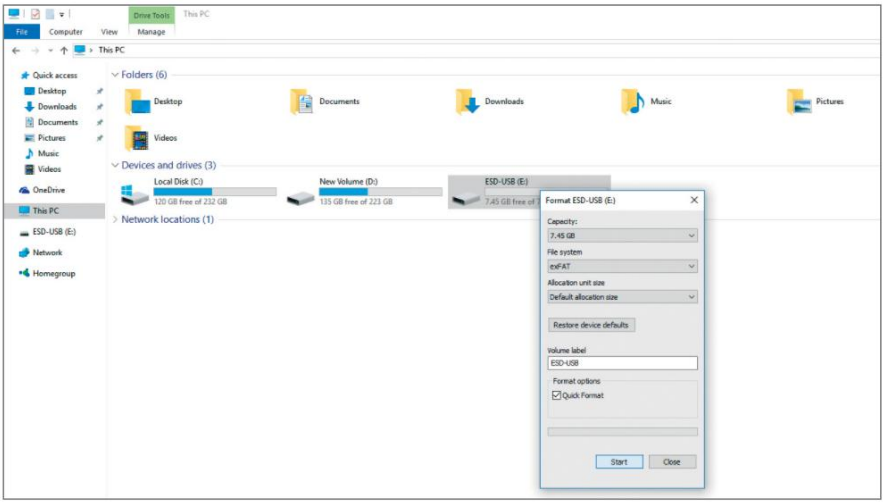
HOW TO

STEP-BY-STEP GUIDES TO IMPROVING YOUR PC

WINDOWS TIP OF THE MONTH


Drive Tools
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Videos
OneDrive
This PC
ESD-USB (E:)
Network
Homegroup
Folders (6)
Desktop
Documents
Downloads
Music
Pictures
Videos
Devices and drives (3)
Local Disk (C:)
120 GB free of 232 GB
New Volume (D:)
135 GB free of 223 GB
ESD-USB (E:)
7.45 GB free of
Network locations (1)

Format ESD-USB (E:)

Capacity: 7.45 GB

File system: exFAT

Allocation unit size: Default allocation size

Restore device defaults

Volume label: ESD-USB

Format options

☑ Quick Format

Start | Close

DEALING WITH APPLE'S STORAGE FORMATS

You've thrown some files on to a memory stick to transfer to a Mac, you insert the stick, try to copy and paste the file across, and… it doesn't work. Say hello to the plague of exFAT. Apple hasn't accepted that there might be more than one file format worth recognizing, and if you're rocking NTFS, you're out of luck. So throw your USB stick back into Windows, open "My Computer," right-click the device, select "Format," choose "exFAT" from the "File System" menu, and click "Quick format."

MAKE – USE – CREATE

58
Build your own PiBot monitor

64
Create a multiple exposure image

66
Build a fast, locked quad-core machine

ZAK STOREY
STAFF WRITER

A LITTLE ITX INTELLIGENCE

I'll be the first to admit, I love trying out different form factors. Over the last five years, I've owned, built, and worked on systems ranging from ITX gaming PCs all the way up to E-ATX workstations. Interestingly, one of those form factors attracted far more abuse from friends and associates than the others: ITX.

The thing is, besides being limited to one PCIe slot, there's not a huge difference between ITX and the specs above it. After all, for the vast majority of people, you won't be running SLI or CrossFire, you won't be running an additional PCIe SSD, and you won't be plugging in eight hard drives at any given time. In today's world, there are so many ways to be smarter with your money. Thinking about SLI? Grab the next card up instead. Need 6TB of extra storage? Buy yourself a cheap NAS, or even an external hard drive. Want high quality sound? An external DAC is by far the superior option.

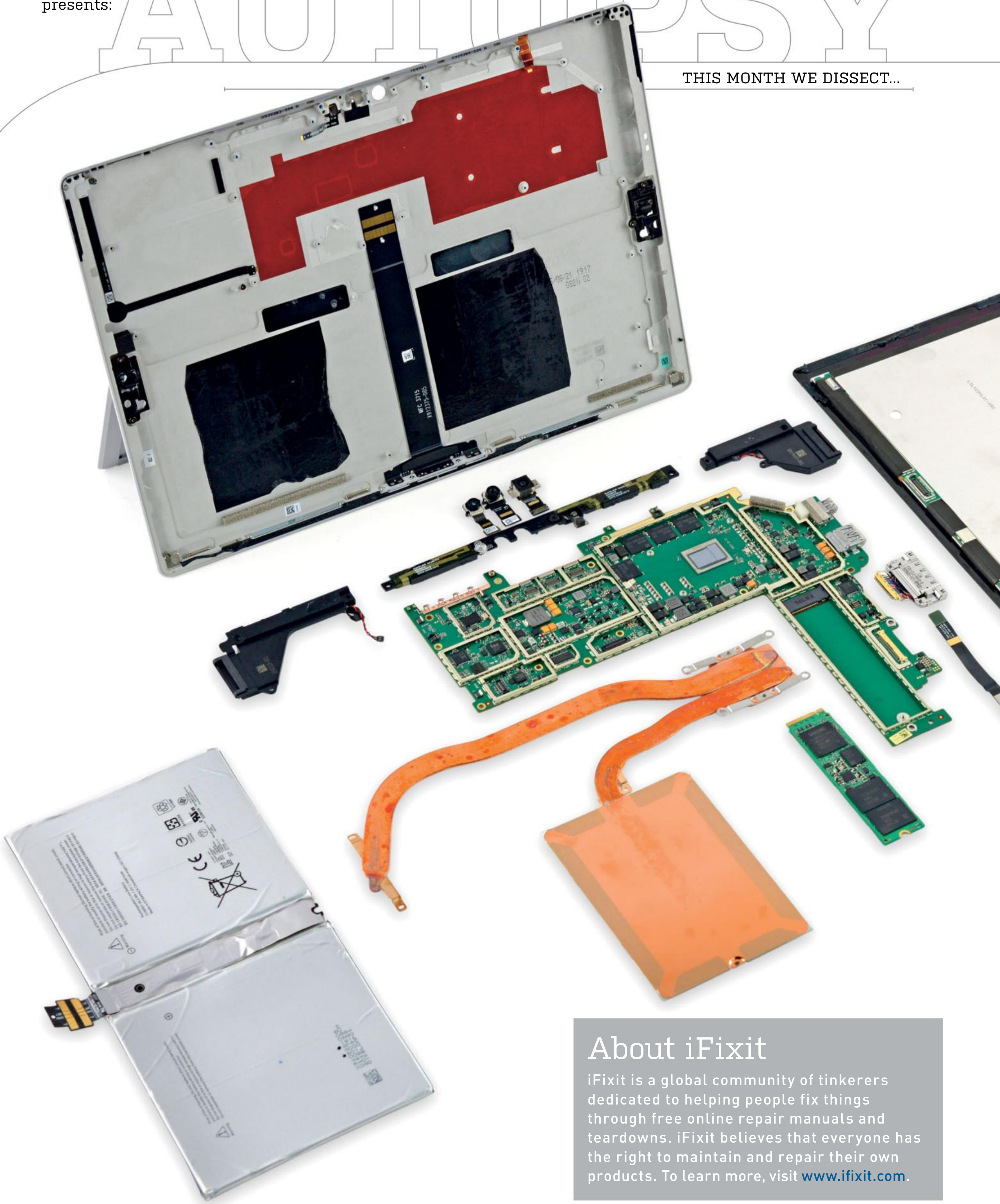
You get the point. If you're budget-conscious, and are building a new rig from scratch, more often than not you can get away with using a smaller motherboard. Take Asus's Z170i Pro Gaming. It supports 32GB of RAM, has one M.2 PCIe slot, four SATA 6 slots, and comes with plenty of overclocking headroom to boot. What I'm trying to get at here is that efficiency is key. If you're not using it, you don't need it. And if you do need it, it's probably not on an ITX board anyway.

↘ submit your How To project idea to: comments@maximumpc.com

IFIXIT presents:

AUTOPSY

THIS MONTH WE DISSECT...

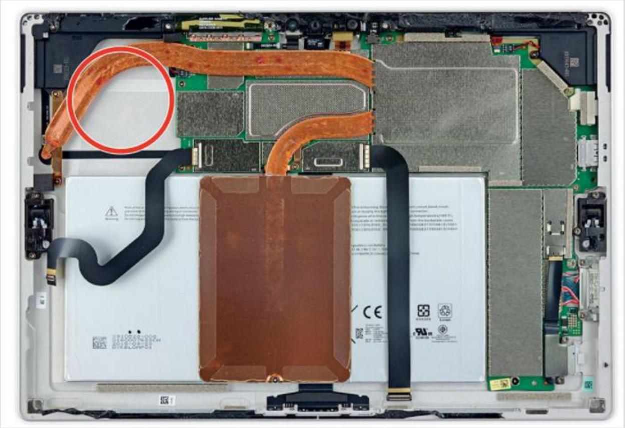


About iFixit

iFixit is a global community of tinkerers dedicated to helping people fix things through free online repair manuals and teardowns. iFixit believes that everyone has the right to maintain and repair their own products. To learn more, visit www.ifixit.com.

Microsoft Surface Pro 4

All of the pain!



We believe this blank space, circled above, is for the hybrid cooling system absent from the 4.5-watt Core M3 model.

BACKGROUND:

Anyone else sick of apples? Time to take a bite out of a juicy Microsoft offering, the Surface Pro 4, to see what it's made of. We're hoping Microsoft has opted for a more fixable laplet (laptop+tablet, eh?) this time. There's only one way to find out... OK, two ways—we have X-ray vision. It's teardown time!

MAJOR TECH SPECS:

- 12.3-inch PixelSense 2736x1824 (267ppi) IPS LCD display
- Intel Skylake Core m3 (4M Cache, 2.2GHz) up to Core i7 (8M Cache, 3.8GHz)
- 4GB/8GB/16GB DDR3L 1,600MHz RAM
- 128GB/256GB/512GB/1TB of PCIe solid state storage
- 8MP rear-facing 1080p camera, 5MP front-facing camera
- USB 3.0 port, microSD slot, mini DisplayPort, and SurfaceConnect charging port
- 802.11a/b/g/n/ac dual-band Wi-Fi and Bluetooth 4.0

KEY FINDINGS:

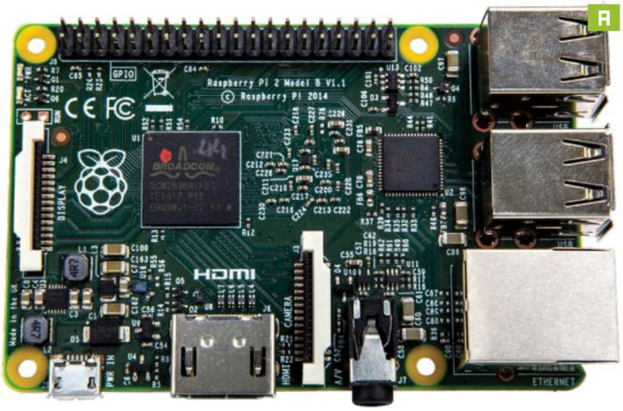
- Sticky nightmares haunt our engineers after the harrowing Surface Pro 3 teardown, so we've prepared for the worst. Things start to heat up as the iOpener battles to weaken the display's adhesive. As soon as we get an opening pick under the edge of the display, we're off! We strain our ears to listen for the telltale cracking of glass, but it seems as though we're getting away with this opening procedure shard-free!
- The last time we tore down a Surface Pro, we encountered a display connector trapped beneath a springy metal bracket. This time, there are two cables holding the display to the body. Our only recourse: tackle those connectors. And, of course, Microsoft has modified its connector design. The display connectors are relatively common press-on types—similar to an iPhone display—but they're trapped under snap-on metal shields.
- The motherboard is so close, yet so far. Unable to wait, we skip to dessert and pop off some shields to get a closer look. The rest of the motherboard is nestled too snugly to investigate, but that SSD looks ripe for the picking. The Surface 4's Samsung SSD is considerably larger than the little whipper snapper we saw in the previous generation.
- The iOpener comes out for an encore, loosening the tough adhesive that holds the battery in place. It finally comes free after a great deal of sweat, tears, and prying. Not much has changed here—the adhesive is still extremely challenging.
- Repairability Score: 2 out of 10 (10 is easiest to repair). The SSD is replaceable. The battery is not soldered to the mobo, but very strong adhesive makes removal hazardous. Non-standard connectors make for tricky display removal, but it's not as hard as in previous generations, due to less stubborn adhesive. The display assembly consists of a fused glass panel and LCD, and is difficult to remove and replace. ⏻

Build Your Own PiBot Monitor

YOU'LL NEED THIS

RASPBERRY Pi 2
The brilliant mini-computer costs under $45. See www.raspberrypi.org.

DO YOU USE YOUR RASPBERRY PI for a headless project, such as a media player, NAS server, seed box, or security camera? If you do, then your Raspberry Pi is probably tucked out of the way somewhere that's not particularly easy to access. You can always log in to it remotely but how do you monitor it in real time? How do you know whether it's overheating? Or running out of disk space? In this project, we're going to play God and make your Raspberry Pi self-aware, and give it the ability to communicate with you. –**MAYANK SHARMA**


A

1 REGISTER AN XMPP ACCOUNT

We need to install the sendxmpp tool on the Raspberry Pi [**Image A**], which allows it to communicate via the popular XMPP messaging protocol. We will use this to send notifications to us via instant messages whenever a predetermined event is triggered. First up, you'll need to get an XMPP IM account for the Pi. If you aren't using an XMPP server already, you can register with any of the publicly listed XMPP servers (https://xmpp.net/directory.php). We're using the https://jabber.hot-chilli.net service, which gets a top-notch security rating from https://xmpp.net, and allows you to register an account on the website itself. Once you've registered an account for your Raspberry Pi, make sure you add it as a friend on your regular IM account, on which you want to receive notifications.

2 INSTALL SENDXMPP

Now log in to the Pi, update the repos, and then download the sendxmpp tool with:

```
sudo apt-get install sendxmpp
```

It's a Perl script and it will pull in the required Perl dependencies. When it's installed, create a file named ".sendxmpprc" under your home directory with the credentials of the Pi's XMPP account, such as:

```
$ nano ~/.sendxmpprc
rpibot@jabber.hot-chilli.net   my-secret-password
```

›› Remember to replace the username and password with the credentials for the account you registered for the Pi. After saving the file, you can send a message with:

```
$ echo “Hi, this is Pi!” | sendxmpp -t geekybodhi@jabber.
hot-chilli.net
```

›› The above command sends a message from the Pi to the XMPP ID specified with the "-t" option. Swap out the ID in the example above with your own XMPP ID. If you're signed in to your regular IM account, you'll receive the greeting as a regular message from the Pi's XMPP account.

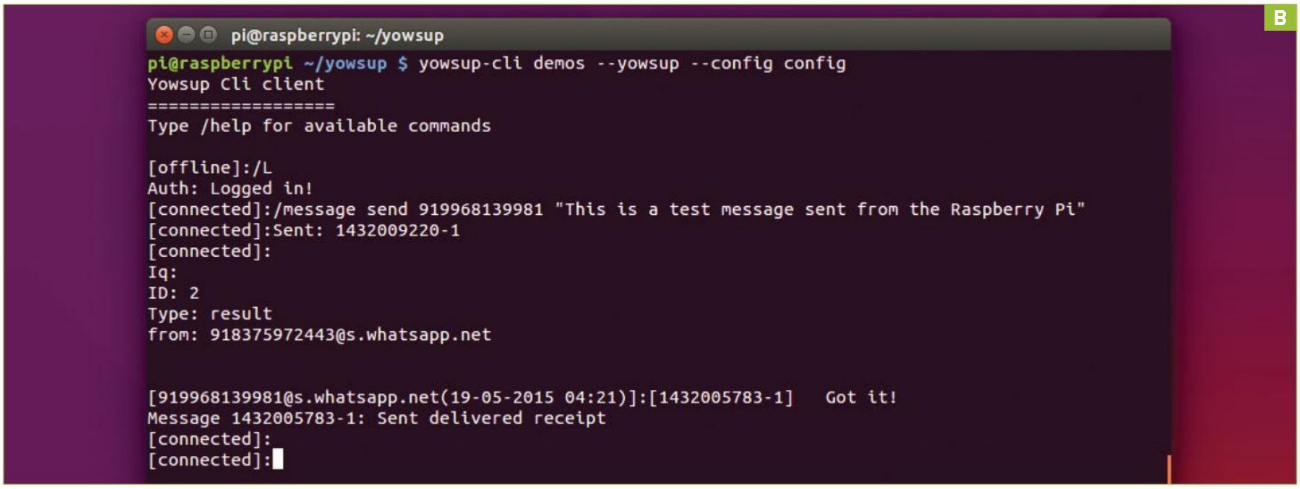
›› You can also pass output of Bash commands, such as:

```
$ echo “It is” $(date) | sendxmpp -t geekybodhi@jabber.
hot-chilli.net
```

›› This command sends the output of the "date" command. Here's another example that's a bit more useful:

```
$ echo $(/opt/vc/bin/vcgencmd measure_temp) |
sendxmpp -t geekybodhi@jabber.hot-chilli.net
```

›› This command queries the temperature sensors on the Pi using the utilities installed by the raspberrypi-


B

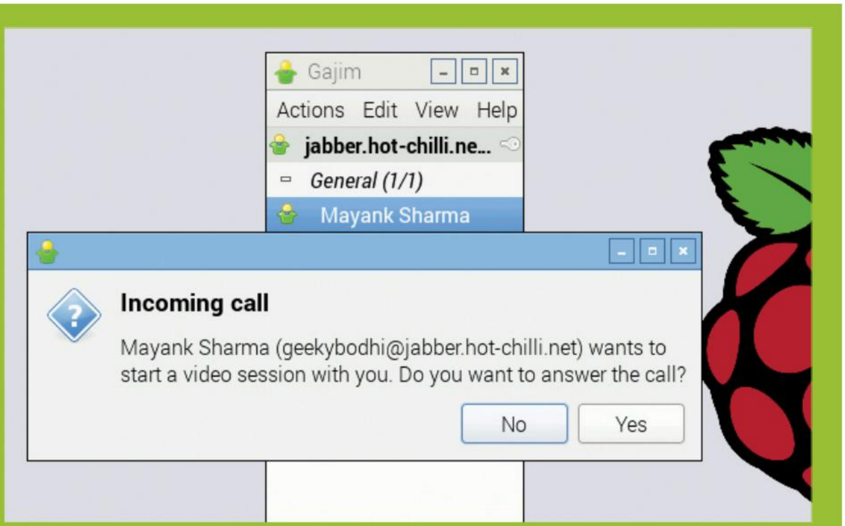
```
pi@raspberrypi ~/yowsup $ yowsup-cli demos --yowsup --config config
Yowsup Cli client
==================
Type /help for available commands

[offline]:/L
Auth: Logged in!
[connected]:/message send 919968139981 "This is a test message sent from the Raspberry Pi"
[connected]:Sent: 1432009220-1
[connected]:
Iq:
ID: 2
Type: result
from: 918375972443@s.whatsapp.net


[919968139981@s.whatsapp.net(19-05-2015 04:21)]:[1432005783-1]   Got it!
Message 1432005783-1: Sent delivered receipt
[connected]:
[connected]:
```

VIDEO CHATS

If you're using the Raspberry Pi 2 as a regular desktop, you can install an IM client and converse with your friends either via text or video. The XMPP protocol we've discussed in this tutorial is one of the most popular ones for exchanging instant messages, and is used by services such as Google Chat.

One of the best XMPP clients for the Raspberry Pi, with the right balance of size and features, is Gajim. It's available in the official Raspbian repos, and you can install it with a simple command: "$ sudo apt-get install gajim"

Once installed, you can hook it up to your XMPP account and exchange text messages with your friends. You can also hook up a webcam to the Pi and make video calls to your buddies. But for that, you'll first have to make sure you've got the gstreamer1.0-plugins-bad and python-farstream packages. Both are available in the official Raspbian repos, and can be installed with the APT package manager. Once you have installed the webcam and the required components, your chat window now features a button that enables you to start a video session. If you have trouble transmitting audio or video, head to "Edit → Preferences → Audio/Video," and make sure you're using the correct audio output device. If you're on a limited connection, you can reduce the video size by picking a lower resolution from the "Video Size" menu.



Incoming call

Mayank Sharma (geekybodhi@jabber.hot-chilli.net) wants to start a video session with you. Do you want to answer the call?

firmware-tools package, which we then pipe to our regular IM user. You can use this statement to monitor the Pi and send you an alert over IM when the temperature crosses a preset threshold. Copy the contents of Listing 1 (see pg. 61), or nab it from http://pastebin.com/NdQw5frt in a file called "status.sh." Then set a crontab entry by running "crontab -e" and entering the following line:

```
*/5 * * * * ~/status.sh
```

›› Here we are asking the Pi to run the status.sh script every five minutes. Remember to change the location of the status.sh file to the location on your Pi. So what's in the status.sh script? The script stores the temperature of the Pi in a variable named "temp," after stripping out the verbose text and the decimal, because Bash can only handle integers. The script then checks whether the value is greater than 40°C, and if it is, alerts us with a message. You can extend this script to keep track of the goings-on in the Raspberry Pi. For example, you can ask it to send you alerts whenever it finds a particular message in a log file, or whenever the status of a daemon changes. The sendxmpp script helps you keep track of the activities on the Pi—however, you can't act on them without logging in to the Pi. But what if this isn't possible? What if you get a temperature warning from the Pi monitoring your home while you're away at work? Wouldn't it be great if you could control the Raspberry Pi via messages as well?

3 YOUR BEST BUDDY

WhatsApp is one of the most popular messaging apps, and you can use it with the Pi. The Yowsup Python library [**Image B**] enables you to use your WhatsApp account to exchange messages with your contacts. After the novelty of messaging your friends from the Pi wears off, you can use the Yowsup library to monitor and control the Pi by sending messages via WhatsApp.

Before you can install the Yowsup library, you should fetch its dependencies with:

```
$ sudo apt-get install git python-dev libncurses5-dev
```

›› Then use:

```
$ git clone git://github.com/tgalal/yowsup.git
```

to download the library under the current directory, and install it with:

```
$ cd yowsup
$ sudo python setup.py install
```

›› Once the library is installed, it's time to register your mobile number with WhatsApp. In the "yowsup" directory, create a file called "mydetails" with the following:

```
$ nano mydetails
cc=1
phone=17712345678
```

›› The "cc" option points to the country code, which is 1 in the United States. Replace it and the phone number with your particulars. Make sure you don't enter the "+" symbol. Then save the file and use the following to ask WhatsApp for a registration code:

```
$ python yowsup-cli registration --config mydetails
--requestcode sms
```

4 ENTER YOUR CODE

After a few seconds, you should receive an SMS on the phone with the SIM card for the number you have entered in the mydetails file. The message contains a six-digit code. Use this code to register your cell number with WhatsApp:

```
$ python yowsup-cli registration --config mydetails
--register xxx-xxx
```

›› Replace "xxx-xxx" with your code. After a second or two, you'll receive a response from WhatsApp on the Pi, which will look something like this:

```
status: ok
kind: free
pw: jK0zdPJ9zz0BBC3CwmnLqmxuhBk=
price: 0.99
price_expiration: 1434674993
currency: USD
cost: 0.99
```

```
expiration: 1463544490
login: 448375972334
type: new
```

» The only bit of information we're interested in is the password mentioned with the "pw" variable. Copy it and paste it in the mydetails file, which should now read:

```
cc=1
phone=17712345678
password=jK0zdPJ9zz0M8G3CwmnLqmxuhBk=
```

» That's all there's to it. The Yowsup library includes a demo application, which you can use to send and receive messages. Bring it up with:

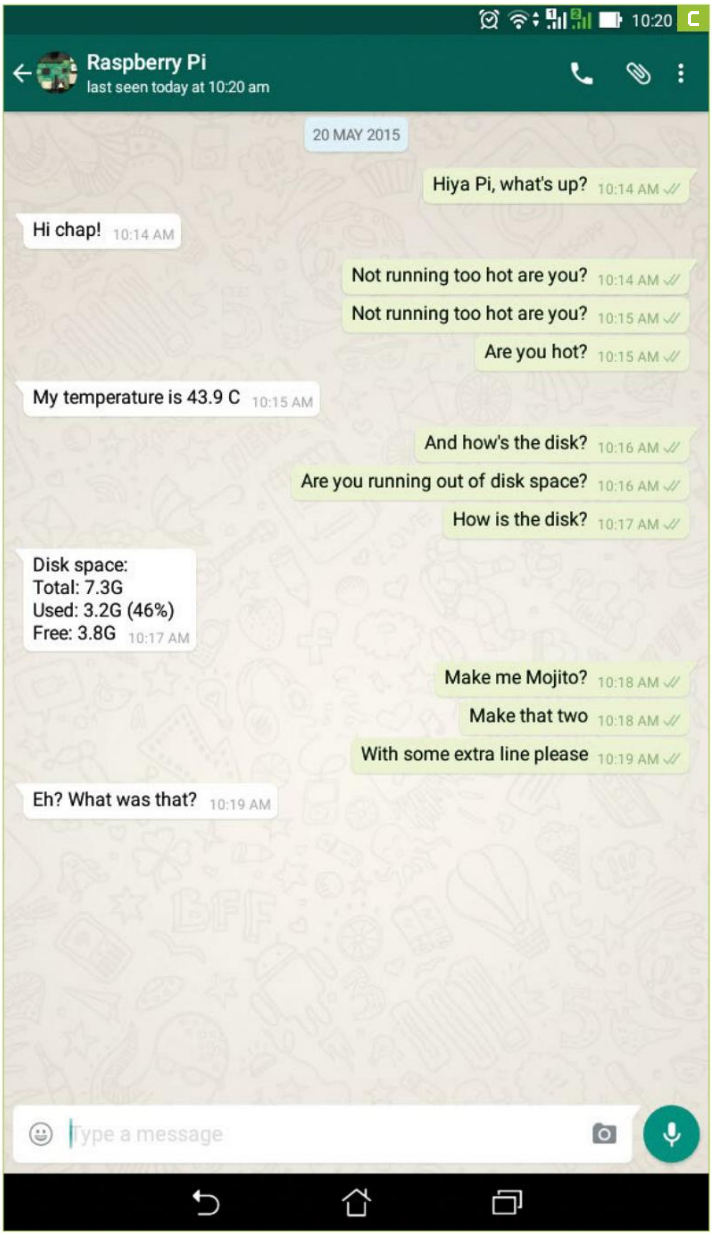
```
$ yowsup-cli demos --yowsup --config mydetails
```

» This brings up the Yowsup command-line client. Type "/help" to see all the available commands. The "[offline]" prompt indicates that you aren't connected to the WhatsApp servers, so use the "/L" command, which picks up the authentication information from the mydetails file and connects to the server. The prompt now changes to "[connected]". You can now send messages to other WhatsApp users. To send a message to 19988776655, for instance, enter:

```
/message send 19988776655 "Hiya mate, I'm
sending this from the Raspberry Pi!"
```

» If the recipient responds with a message, it is displayed on the console on the Raspberry Pi. To end the session, use the "/disconnect" command to quit.

ANOTHER PI TUTORIAL NEXT MONTH



10:20

Raspberry Pi
last seen today at 10:20 am

20 MAY 2015

Hiya Pi, what's up? 10:14 AM

Hi chap! 10:14 AM

Not running too hot are you? 10:14 AM

Not running too hot are you? 10:15 AM

Are you hot? 10:15 AM

My temperature is 43.9 C 10:15 AM

And how's the disk? 10:16 AM

Are you running out of disk space? 10:16 AM

How is the disk? 10:17 AM

Disk space:
Total: 7.3G
Used: 3.2G (46%)
Free: 3.8G 10:17 AM

Make me Mojito? 10:18 AM

Make that two 10:18 AM

With some extra line please 10:19 AM

Eh? What was that? 10:19 AM

5

WHAT'S UP, PI?

Of course, the real advantage of the Yowsup library is that it can be used to invoke various useful actions on the Raspberry Pi. For example, you can send a WhatsApp message to check certain details on the Pi, such as its free disk space or temperature, then maybe update it or shut it down. You can also use it to influence the GPIO pins, and control any connected peripherals—a door, for example.

» You can use the Python script in Listing 1 (right) to interact with the Pi. The script listens to messages from a certain predefined number, recognizes certain keywords, and responds accordingly. So if you send something such as "Hiya Pi," it greets you back. If it receives a message that begins with "memory," the Pi executes the "df -h" command, and messages you the results.

» The script uses classes created by Italian blogger Carlo Mascellani. They are housed with two files, named wasend.py and warecieve,py, which you can download by entering:

```
$ wget http://www.mascal.it/public/wasend.py
$ wget http://www.mascal.it/public/wareceive.py
```

» In the same directory, create a file called pitalk.py with the contents of Listing 2 (right). Now create a shell script called talktome.sh that calls the pitalk.py Python script:

```
$ nano talktome.sh

#!/bin/bash
while :
do
sudo python /home/pi/yowsup/pitalk.py
done
```

6

EXECUTE THE SCRIPT

Now make it executable with "chmod +x talktome.sh" and make sure it runs automatically whenever the Pi boots up by pointing to it in the /etc/rc.local file:

```
$ sudo nano /etc/rc.local
/home/pi/yowsup/talktome.sh
```

» Save the file and reboot the Raspberry Pi, and the script starts automatically.

7

PARSING THE SCRIPT

Let's break down the script to understand it better. The "credential()" function at the top helps connect the script to the WhatsApp server by using the credentials for your account. Make sure you edit both the parameters in this function. The "Answer()" function specifies the WhatsApp number our Pi communicates with. This is important, because we don't want just anybody to control our Raspberry Pi.

» Then we define the functions that do the actual tasks we query the Pi for via the WhatsApp messages—e.g. the "Refresh()" function refreshes the repository list, and "Restart()" reboots the Pi. The "Temp()" and "Disk()"

functions are a little more complex. The former fetches and truncates the temperature information, as illustrated earlier in the tutorial. Similarly, "Disk()" formats and rearranges the output of the "df -h" command for easier reading.

» In the main part of the program (the "while" loop), the script waits for a message, and when it gets one, it raises a "MessageReceived" exception. The received message begins with a phone number followed by a message, such as "19876543210Message."

8

GOING FURTHER

When it raises the exception, the script first converts the whole string to lowercase with the "value.lower()" method. It then checks whether the message is from the number it's supposed to respond to. If it isn't, the script appends it to a log file and doesn't respond.

» If, however, the phone number is correct, the script then strips the number from the message and just leaves the textual bit. The "If" conditions then parse the message to decide how to respond. We've used different types of matching to give you an idea of what's possible. The first two look for matching characters at the start of the text—e.g. "if received[:4]=="hiya": Answer("Hi chap!")" is triggered if the first four characters of the message are h, i, y, and a, and responds with "Hi chap!" This condition is met even if the message it receives is, "Hiya Raspberry Pi, are you online?" The second also looks for matching characters at the beginning of the message, but is triggered if it finds either of the two strings ("restart" or "reboot").

» The next three do a different kind of matching. They're triggered if their corresponding text is in any part of the message and not just at the beginning. So if you send a "What's the status of your disk?" message **[Image C]**, the script picks up the "disk" keyword and triggers the "Disk()" function. Similarly, if you send a "You're not running too hot, are you?" message, the script picks up the "hot" keyword, and responds with a readout from its temperature sensor. If it fails to pick up any keywords, the scripts just responds with the "Eh? What was that?" message.

» You can extend this script for a variety of home automation tasks. You can even hook up the Pi camera module and use the Python Picam library to take pictures or videos, and send them to you via a WhatsApp message. Check the Yowsup library's wiki page (https://github.com/tgalal/yowsup/wiki) for some examples of rolling the script into usable applications.

LISTINGS

In this tutorial we use two scripts, which you can download from http://pastebin.com/NdQw5frt.

Listing 1: status.sh

```
#!/bin/bash
temp=$(/opt/vc/bin/vcgencmd measure_temp | cut -c6-7)

if [ "$temp" -gt 40 ]; then
  echo Whoa! My temperature is up to $(/opt/vc/bin/
vcgencmd measure_temp). Power me down for a bit! |
sendxmpp -t geekybodhi@jabber.hot-chilli.net
fi
```

Listing 2: pitalk.py

```
import os, subprocess, yowsup, logging

from wasend import YowsupSendStack
from wareceive import YowsupReceiveStack,
MessageReceived

def credential():
  return
"17712345678","jK0zdPJ9zz0BBC3CwmnLqmxuhBk="

def Answer(risp):
  try:
    stack=YowsupSendStack(credential(), [(["17668139981",
risp])])
    stack.start()
  except: pass
  return

def Refresh():
  Answer("Refreshing the repos.")
  os.system("sudo apt-get -y update")
  Answer("Repos updated.")
  return

def Restart():
  Answer("Rebooting")
  os.system("sudo reboot")
  return

def Temp():
  t=float(subprocess.check_output(["/opt/vc/bin/vcgencmd
measure_temp | cut -c6-9"], shell=True)[:-1])
  ts=str(t)
  Answer("My temperature is "+ts+" C")
  return

def Disk():
 result=subprocess.check_output("df -h .", shell=True)
   output=result.split()
  Answer("Disk space:\nTotal: "+output[8]+"\nUsed:
"+output[9]+" ("+output[11]+")\nFree: "+output[10])
 return
while True:
  try:
     stack=YowsupReceiveStack(credential())
     stack.start()
  except MessageReceived as rcvd:
     received=rcvd.value.lower()
     if received[:len("17668139981")]=="17668139981":
        received=received[len("17668139981"):]
        if received[:4]=="hiya": Answer("Hi chap!")
  elif received[:7]=="restart" or received[:6]=="reboot":
Restart()
   elif "disk" in received: Disk()
   elif "hot" in received: Temp()
elif "refresh" in received: Refresh()
     else: Answer("Eh? What was that?")
   else: #message from wrong sender
        with open("/home/pi/whatsapp.log","a") as mf:
mf.write("Unauthorized access from: "+received[:len("91996
8139981")]+"\n")
```

Manage Passwords With KeePassX

YOU'LL NEED THIS

KEEPASSX
Store your passwords securely on your machine with this free tool from www.keepassx.org.

Wherever you go these days, you need passwords. The number of websites that expect you to provide a username and password to access all their content is even greater than the number of sites providing helpful advice on good and bad practice for passwords. So what are we to do? You should already be using a secure operating system, but any system is only as secure as its users. Passwords are less effective once they are written on pieces of paper stuck to the sides of monitors, or saved in text files. The three questions we will try to answer here are: How should I choose my passwords, how can I check that my passwords really are secure enough, and how do I keep track of them without resorting to pieces of paper? –**NEIL BOTHWICK**

1

KEYS TO THE KINGDOM

Ask people which they think is their most important password, and many will say that it is their login password (unless they use a password manager, in which case it may be that one). It isn't, though—your login password only gives access to your user account on your computer. The most dangerous password to have compromised is the one to your email account. Why? Think of all the websites you have to log into—how many of them have a "Click here if you forgot your password" link? These links generally send an email with a password reset URL to the email address you registered with them. If someone gets hold of your email credentials, they can use those details to discover your password for many websites, including ecommerce sites that may already hold payment details. It also means they can delete any responses and notifications about password resets, not to mention acknowledgement emails for any orders they may place using your account—so keep your email password safe, secure, and unique.

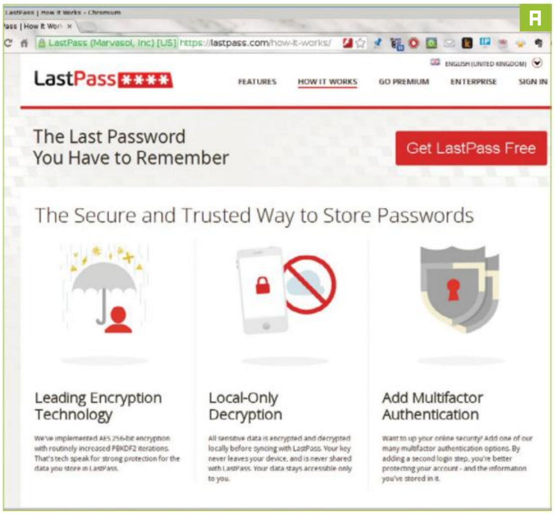
2

DANGEROUS REMINDERS

Even if your password is safe, email is not a secure medium; all data travels as plain text, so it's not a good idea to make a habit of email password reminders and resets. However, most people have more online identities and login names than they can remember passwords for, so how do you remember your passwords without breaking any of the golden rules about reusing the same password or using simple ones?

IF THE WORST HAPPENS

No, we're not talking about drunken mates discovering your Facebook password and making embarrassing status updates on your behalf. None of us will be here forever, so we should make sure there is a way for our families to access our online information and know about online billing when our time is up. When someone died recently, we were asked for help to extract a lot of important password-protected information from his smartphone, because no one else knew the password—as if his wife didn't have enough to worry about at the time. A copy of your password database on a USB stick, along with a note of the password (or details of your online password storage) in a safe place will make it possible for others to sort out your affairs after you're gone.



The Last Password
You Have to Remember

The Secure and Trusted Way to Store Passwords

Leading Encryption Technology

We've implemented AES 256-bit encryption with routinely increased PBKDF2 iterations. That's tech speak for strong protection for the data you store in LastPass.

Local-Only Decryption

All sensitive data is encrypted and decrypted locally before syncing with LastPass. Your key never leaves your device, and is never shared with LastPass. Your data stays accessible only to you.

Add Multifactor Authentication

Want to up your online security? Add one of our many multifactor authentication options. By adding a second login step, you're better protecting your account - and the information you've stored in it.

3

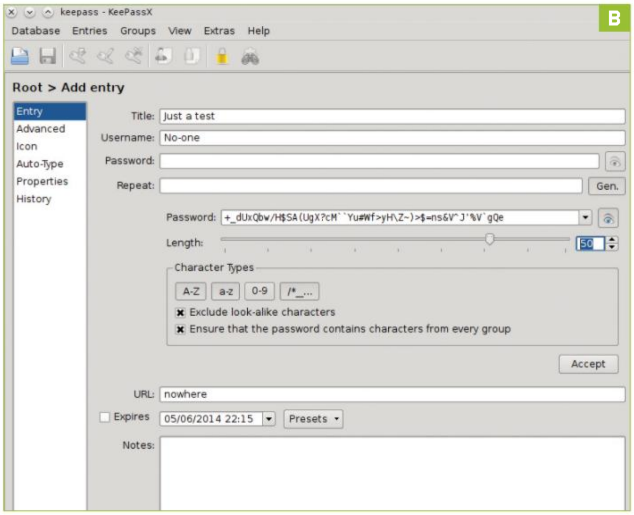
PASSWORD STORAGE

One solution is a password manager. Most web browsers have an option to save passwords, but these are neither universal nor portable. You could use a system such as LastPass (http://lastpass.com) [**Image A**], which stores your passwords and has extensions for most browsers to automatically complete forms. This means you only need to remember the master password, which you can then make more secure. However, such services may restrict you to web usage, and require you to entrust all of your passwords to a third party. Yes, they store the passwords encrypted, but they do so using their own encryption, not yours, so they are potentially susceptible to security breaches.

4

BUILD YOUR OWN

Another option is to keep your own password database, using a program such as KeePassX [**Image B**], which has versions that run on Windows, Mac OS, Linux, Android, and iOS. These all use the same storage format, enabling you to share your password database across any devices you own or have access to, especially if you keep the database itself in some sort of cloud storage, such as Dropbox, or even your own server, using ownCloud or similar.


B
keepass - KeePassX
Database
Entries
Groups
View
Extras
Help
Entry
Advanced
Icon
Auto-Type
Properties
History
Gen.
A-Z
a-z
0-9
/*_...
Accept
Presets

Root > Add entry

Title: Just a test
Username: No-one
Password:
Repeat:
Password: `+_dUxQbw/H$SA(UgX?cM``Yu#Wf>yH\Z~)>$=ns&V^J'%V`gQe`
Length: 50
Character Types
☒ Exclude look-alike characters
☒ Ensure that the password contains characters from every group
URL: nowhere
☐ Expires 05/06/2014 22:15
Notes:

5 CHOOSING PASSWORDS

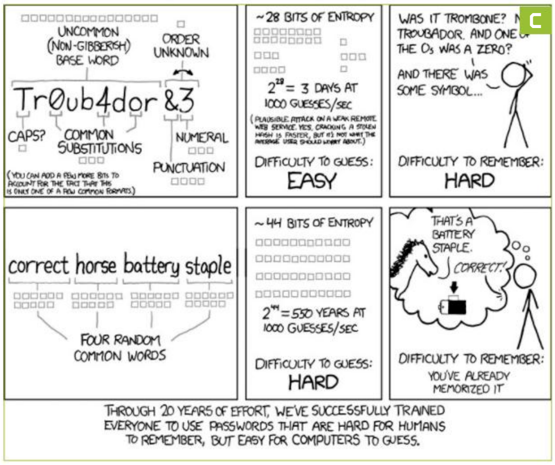
A password that is easy to crack is no use, but neither is one so convoluted that you don't stand a chance of remembering it yourself. If you use a password manager, many of them have an option to generate long, random, cryptic passwords, but you still need a password for the manager, and that has to be really secure. Any password not stored in a database has to be easy to remember but hard to guess.

6 COMPLICATED SIMPLICITY

There's a number of factors that affect the guessability of a password. Using so-called dictionary words—which also include proper nouns, place names, and common names—is a sure way to make your password easy to guess. Other important factors to consider are the number of characters used, and the number of possible choices for each character. Increasing either of these makes the password more secure, which is why it is commonly recommended to use mixed case, numbers, and even symbols.

7 STRONG PASSWORDS

However, these can make passwords far harder to remember, not to mention making them extremely tedious to type on a touchscreen keyboard. So how do you create a password that is long enough to be secure, isn't a dictionary word, and can be typed on a mobile device? One answer is the same way you create a less secure password, several times over. Ask someone to remember a 24-character password, and they will probably not even consider it, but ask them to remember four six-letter passwords, and there will be no such reaction. All you then have to remember is the order of the four words run into one [**Image C**]. You can ring further changes, using numbers in place of some letters, *à la* leet speak, and using mixed case or deliberate misspellings. By doing so, you end up with a more secure password, as long as the four words you choose are unrelated in everyone's mind but your own. Most importantly, though, you can remember it, you do not need to write it down, or worry about forgetting it.


C
UNCOMMON (NON-GIBBERISH) BASE WORD
ORDER UNKNOWN
Tr0ub4dor&3
CAPS?
COMMON SUBSTITUTIONS
NUMERAL
PUNCTUATION
(YOU CAN ADD A FEW MORE BITS TO ACCOUNT FOR THE FACT THAT THIS IS ONLY ONE OF A FEW COMMON FORMATS)
~28 BITS OF ENTROPY
2^28 = 3 DAYS AT 1000 GUESSES/SEC
(PLAUSIBLE ATTACK ON A WEAK REMOTE WEB SERVICE. YES, CRACKING A STOLEN HASH IS FASTER, BUT IT'S NOT WHAT THE AVERAGE USER SHOULD WORRY ABOUT.)
DIFFICULTY TO GUESS: EASY
WAS IT TROMBONE? N TROUBADOR. AND ONE OF THE Os WAS A ZERO?
AND THERE WAS SOME SYMBOL...
DIFFICULTY TO REMEMBER: HARD
correct horse battery staple
FOUR RANDOM COMMON WORDS
~44 BITS OF ENTROPY
2^44 = 550 YEARS AT 1000 GUESSES/SEC
DIFFICULTY TO GUESS: HARD
THAT'S A BATTERY STAPLE.
CORRECT!
DIFFICULTY TO REMEMBER: YOU'VE ALREADY MEMORIZED IT
THROUGH 20 YEARS OF EFFORT, WE'VE SUCCESSFULLY TRAINED EVERYONE TO USE PASSWORDS THAT ARE HARD FOR HUMANS TO REMEMBER, BUT EASY FOR COMPUTERS TO GUESS.

8 BETTER SECURITY FOR ALL

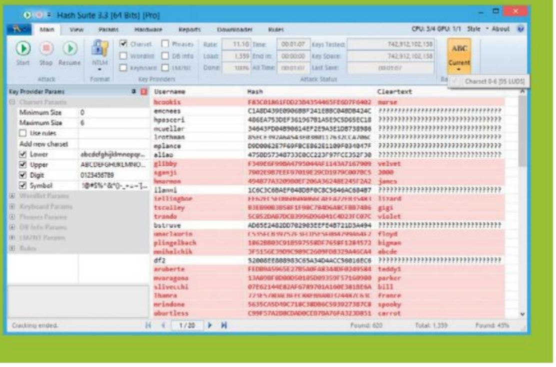
KeePassX uses an encrypted database to store URLs, login names, and passwords for your favorite sites. There are versions available for all desktop and mobile operating systems, so you can keep a single database everywhere. There is even a portable version of the Windows program that you can keep on a USB stick along with its database file.

KeePassX does more than simply store passwords; it can also type them into the browser for you. The default setting is to send the username, a tab, the password, and Enter, but you can change this for each site. Version 2 of KeePassX can be configured to send more than two items. Some sites, particularly banking sites, now require three pieces of information. Cryptic passwords can be generated automatically for each site, or you can pick your own and it will let you know how strong it is. The database is a single file, and an important one, so keep a copy in a safe place. ⏻

TEST YOUR (PASSWORD) STRENGTH!

How do you know whether or not you have a strong password? There's a number of websites that check password strength, and even give an indication of how long they would take to crack, such as https://howsecureismypassword.net. You don't want to give your real passwords to such sites, but you can use them to check the style of password you are using.

Another option is to use a downloadable tool, such as Hash Suite (http://hashsuite.openwall.net), to try to work out your passwords. This is a Windows utility developed by one of the contributors to the respected John the Ripper tool, which is only available for Linux and Mac OSes (www.openwall.com/john). These tools are primarily designed for system admins, but are also useful for anyone who is concerned about the strength of their passwords and system security.


Hash Suite 3.3 [64 Bits] [Pro]
Main
View
Params
Hardware
Reports
Downloader
Rules
Start
Stop
Resume
NTLM
Attack
Format
Key Providers
Attack Status
Current
Key Provider Params
Username
Hash
Cleartext
Cracking ended.
1 / 20

Create a Multiple Exposure Image

YOU'LL NEED THIS

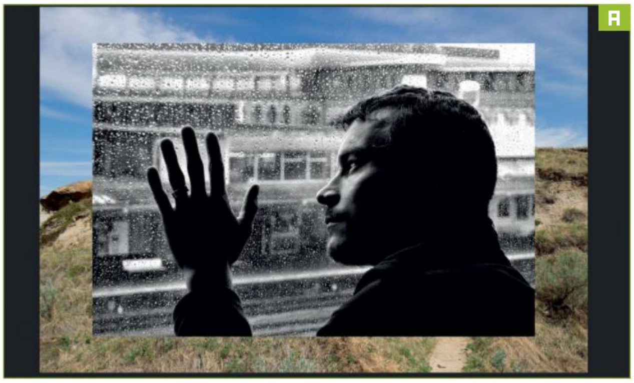
ADOBE PHOTOSHOP
Subscribe to various Adobe packages at www.abobe.com.

PHOTOS
To import and edit.

BACK WHEN CAMERAS USED FILM, clever or accident-prone photographers could make a second exposure by not winding an exposed frame on, burning two images into the emulsion, and ending up with something dark and inexplicable. The really creative ones, however, could produce multiple exposure images of ethereal grace and sublime surrealism.

If you're a fan of underwater photography, it's likely you've seen double exposures at work. Because of the lack of light under the ocean, a flash picture is sometimes taken of fish that leaves the background dark. A second, longer exposure is then taken, often in lighter, shallower water, that adds the background back in, putting a natural blue color or a rippling surface behind the subject.

But we're not here to talk about fish. We want surreal portraits and insane multiple exposure tricks. Many digital cameras don't have this functionality—luckily, we have Photoshop. –IAN EVENDEN



1 CHOOSE YOUR IMAGES

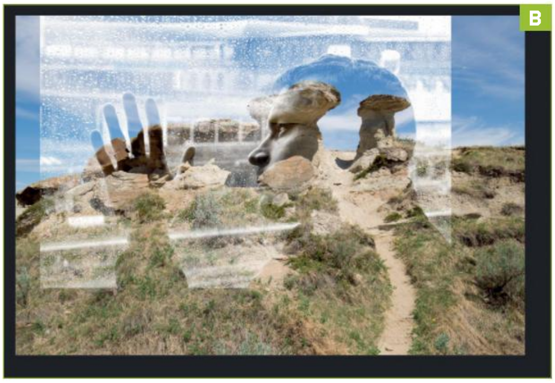
This is a project that needs to be thought about in advance, because it's unlikely you'll come across two perfect images while out on a walk; perhaps you'll be lucky, though. A good choice is a texture that can be blended with a strong graphic shape. An image with a gap in it is often a good choice—a patch of gray sky, say, between two tall buildings [Image A]. Take macro photos of your walls or drapes to find interesting textures, and you can deliberately make one image darker than the other using your camera's exposure compensation settings if you want—or just do it using "Levels" in Photoshop, or "Exposure" in Lightroom.

2 OPEN IN PHOTOSHOP

Open one of your image files in Photoshop, then import the other as a new layer. There are a few ways you can do this. If you're old-school, open it separately, select all (Ctrl-A), then copy (Ctrl-C) and paste into the other image (Ctrl-V). Alternatively, just drag and drop the second image from a folder. It will appear on top of your open image with a cross across it as a Smart Object—you can rotate and resize it into place at this point, before double-clicking the object or clicking the checkmark icon at the top of the interface to render it in place. Both methods put the new image on a separate layer [Image B].

3 BLEND

Photoshop's blend modes make creating this kind of image much easier than it ever was using a film camera. Position the images so they overlap in a pleasing way—use "Free Transform" (Ctrl-T) to get it right; a bit of distortion doesn't really matter when you're creating something as unrealistic as this. Don't worry if the edges of the images don't align—we can crop them later.



4 SCREEN

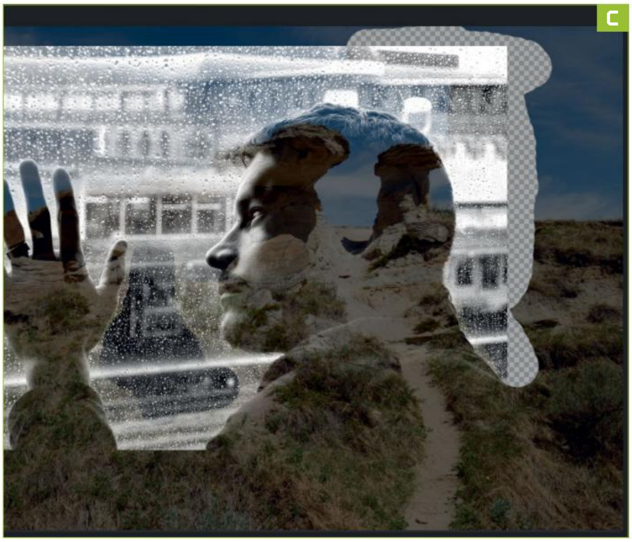
As the two images we've chosen are both properly exposed, we're going to use the "Screen" blend mode to combine them. Screen lightens the resulting composition because it inverts each pixel, multiplies their RGB values together, then inverts again. It's the opposite of "Multiply," which will darken your image. On the "Layer" palette, set the top layer to "Screen," and see what it does to your image. You can use the palette's opacity slider to lessen the effect if it's too much.

5 BRING OUT THE BACKGROUND

Position a new layer immediately above your background layer. Fill it with black using the "Paint Bucket" tool (G—but this often selects "Gradient," so fold out the tool icon to reveal the "Bucket"). Now, change the blend mode of this layer to "Hard Light," and reduce its opacity to around 60 percent. Your background should now be dimmer, showing more of your foreground image.

6 BRUSH OUT SOME FOREGROUND

Select a soft-edged brush tool and paint black over the foreground layer to reveal more of the background. You may need to render the Smart Object first—if you get a no entry symbol when you try to paint on



the layer, right-click the layer in the "Layers" palette, and select "Rasterize Layer." Using the "Eraser" tool on the top layer will have the same effect, but keep the edge soft to avoid hard transitions.

7 ATTACK THE BACKGROUND.

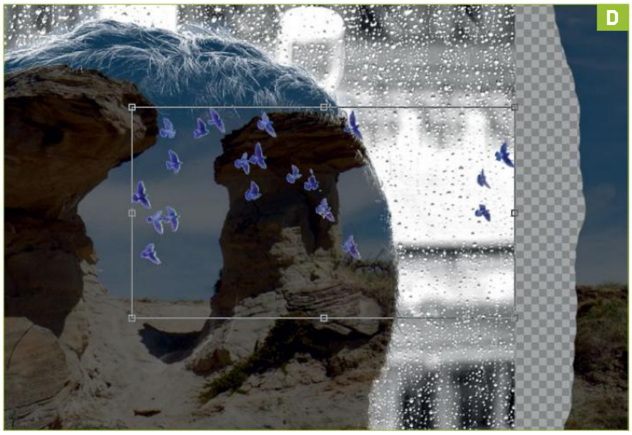
Double-click the background layer to make it into a "normal" layer [**Image C**], then use the "Eraser" tool (E) to brush away any parts you don't want to see showing through in your final composition. Going over the edges doesn't matter, but make sure that anything that falls inside the final crop you've visualized for the image doesn't have obvious hard edges. Drop the brush size down and zoom in to paint around any detailed bits.

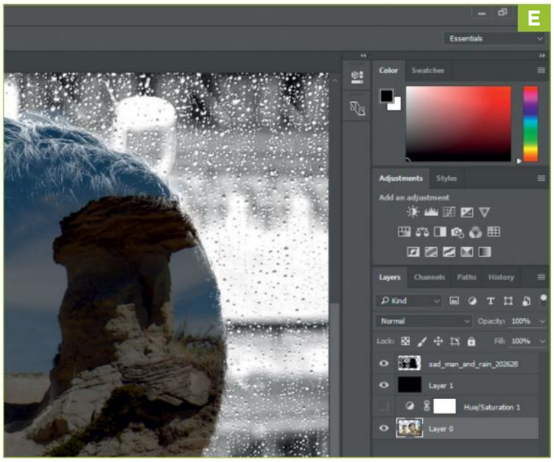
8 EXTRA INTEREST

We think our model is dreaming of the great outdoors, so we're going to add a little wildlife to the composition. We extracted some pigeons from an image using the "Magic Wand" tool (W), then pasted them into our composition as a new layer, placing them between the background and the all-black layer [**Image D**].

9 SATURATION

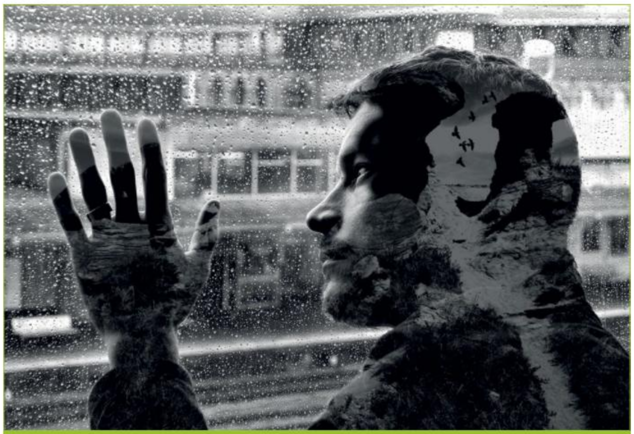
Our foreground image is black and white, and it might be nice to make the background mono as well. On the "Layers" palette, click "Create New Fill or Adjustment Layer," and select "Hue/Saturation." Place this new layer above the background but below the all-black layer, then drag the "Saturation" slider all the way to the left to suck all the color out of the landscape. As we've applied this effect as an Adjustment Layer, you can turn it on and off using the eye icon at the left of each layer's entry in the "Layers Palette" [**Image E**]. This has left our pigeons as the only part of the image in color, so to make them monochrome to match, all we need to do is drag their layer below the Adjustment Layer.





10 FINISHING TOUCHES

To finish, increase contrast using Levels if needed, then use the "Crop" tool (C) to smarten up the edges and remove any parts where your brush has gone wildly over the edge. Save as a PSD file for later editing, then flatten the layers and save as a JPG for printing or sharing. ⏻



LAYER ORDER

The way to think about layers is that you're placing sheets of acetate on an overhead projector, if you remember those from high school. Each layer you put on top has the light from those below shone through it, and it's up to you to control how opaque those layers are.

Photoshop allows many different types of layers in addition to the "normal" and Adjustment Layers we've used here. These include the useful "Selective Color" layer, which enables you to control which colors show through from the layers below, and the "Gradient" layer, which enables you to mask off one end of an image, and gradually reveal it as the gradient becomes less dark.

BUILD IT

ALEX CAMPBELL **ASSOCIATE EDITOR**

Furiously Fast on the Core i5

It's time to prove you can get some impressive performance from a locked quad-core

LENGTH OF TIME: **1-3 HOURS** LEVEL OF DIFFICULTY: **MEDIUM**

THE SLAB

IF THERE'S ONE THING we love to have in a build, it's an unlocked CPU. While we don't always overclock our published builds, it's hard to overstate the value that some get from overclocking. There's the "free" upgrade, the satisfaction of customizing and tweaking something yourself, and the thrill of pushing a CPU to its limit.

But not everyone needs to overclock. Most people will never enter the UEFI BIOS, let alone risk voiding a warranty on a part that costs $200 or more. There's another price of overclocking, too, and it's measured in dollars. K-model CPUs are more expensive than their locked counterparts. For a first-time builder or someone on a budget, it's difficult to justify buying a K-model CPU when a locked model does most of the stuff you need it to do.

That's not to say you can't get great performance from a locked CPU. In this build, we set out to assemble a machine that called upon the Core i5-6500, a locked quad-core that's fairly inexpensive. We found that this CPU—the Skylake successor to the Haswell i5-4570—can still get the job done.

ALL IN ON GRAPHICS

ONE OF THE THINGS WE WANTED TO TEST in this build was how a high-end GPU would perform with the humble Core i5-6500. We picked the Asus R9 Fury Strix to push pixels in this build, and complemented the system with 8GB of DDR4 RAM.

We installed our CPU, GPU, and RAM on to an EVGA Z170 Stinger mini-ITX motherboard. The Stinger was one of the first Skylake motherboards we got our hands on, but it's been spending its days on a shelf in the office. We took it from its hiding spot and pressed it into service.

For storage, we turned to one of our favorite SSDs: the 250GB Samsung 850 Evo. With impressive speed and a decent price, the 250GB Evo really is a great base for any PC. This particular SSD was the 2.5-inch model, which we've been trying to wean ourselves away from, opting instead for the M.2 form factor. Unfortunately, not every motherboard supports M.2—while the Stinger does support M.2, it only has room for the shortest of M.2 cards, which we feel is aimed at Wi-Fi expandability, rather than storage.

We put all of these parts into NZXT's new Manta mini-ITX case, which we've reviewed this issue (see pg. 77).

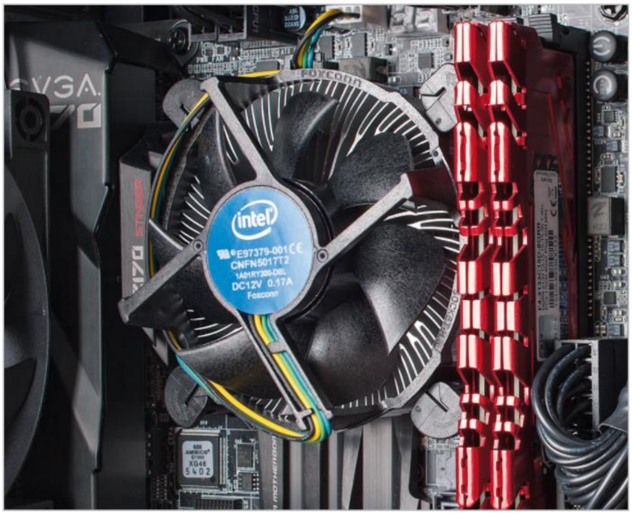
INGREDIENTS

PART		STREET PRICE
Case	NZXT Manta	$140
Motherboard	EVGA Z170 Stinger ITX	$180
CPU	Intel Core i5-6500	$205
Memory	8GB (2x 4GB) G.Skill Ripjaws 4 Series DDR4-2133	$38
GPU	Asus R9 Fury Strix	$540
PSU	EVGA SuperNOVA NEX 650W 80 Plus Gold	$90
SSD	Samsung 850 Evo 250GB	$88
Total		$1,281

1 BASIC COOLING

ONE OF THE BAD THINGS about getting a K-model Skylake CPU is that you're forced to buy a cooler of some sort. The Core i5-6600K and the i7-6700K both come without heatsinks or fans in the box, so the onus is on the builder to make sure the chips don't overheat. The Core i5-6500 doesn't have that problem.

Intel's stock heatsinks and fans are made by Foxconn (if you look closely, you can see the parts stamped with Foxconn's name). They're far from sexy, but they're effective, low profile, and don't consume much power. And if you're building a PC with a locked CPU, there's really no compelling reason to go out and spend money on a bigger heatsink. Using the stock heatsink and fan also saves time, because installation takes all of about 15 seconds, provided everything is done correctly.



2 ROOM FOR THE BIG GUYS

THE ASUS R9 FURY STRIX is a big card, and using it in a mini-ITX build can sound counter-intuitive. The typical logic that a mini-ITX build means using a small, underpowered card didn't hold true with the Manta.

The front of the Manta actually had plenty of room to spare, which gives us confidence that using a big card such as the Fury Strix with a thick radiator wouldn't pose much of a problem. The front of the Manta comes off easily, allowing for easy fan and radiator mounting.

The two fans you see here come pre-installed, which offers plenty of airflow for the Fury and our air-cooled CPU. It's a good thing, too, because the video card sits just above a partition for the PSU and hard drives. Without plenty of cool air being forced over the card, pulling cool air in from that relatively tight space could be a little tougher.

3

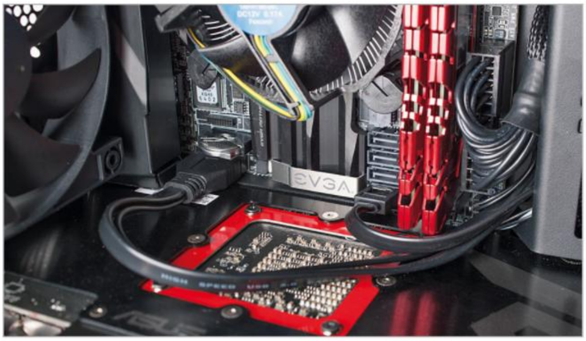
RUNNING CABLES

IF THERE'S ONE THING that will frustrate a builder in a mini-ITX system, it's the location of SATA and USB 3.0 connectors.

When connecting the cables for this rig, we were forced to run them over the top of the RAM DIMMs. While this isn't a big deal, having a clean-looking motherboard compartment is half the reason people buy cases with windows. They don't want to see clutter; they want to see their components in all their glory.

We had to curb our obsessive-compulsive need for a totally clean presentation for the sake of functionality. After all, the machine has to boot, right? And two little cables are far from the worst offenses when it comes to presentation.

It's also worth noting in this photo that the Fury Strix's backplate looks quite nice in this case, and serves to help camouflage the cables slightly.



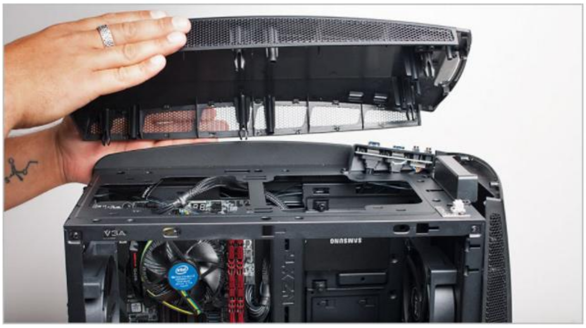
4

HATS OFF

WE ALREADY MENTIONED that the Manta has plenty of room up front for a radiator and fans, but it would be a shame to leave out what the Manta offers up top. The top of the case is easily removed with a few round tabs found inside. It was only after we tried putting the top back on that we realized that taking off the front panel makes removing the top much, much easier.

The top panel has enough space to accommodate a radiator like that found on the Kraken X61. It looks like there's room to add fans, too. Even if your radiator and fan combo are too big, you can always try hanging the radiator below the bracket and mounting the fans on top (or vice versa).

One thing we noticed here was the lack of a dust screen. It's not the worst thing in the world, and we're forced to wonder where one would be added if it could have one. But having a screen is almost always preferable to not having one.

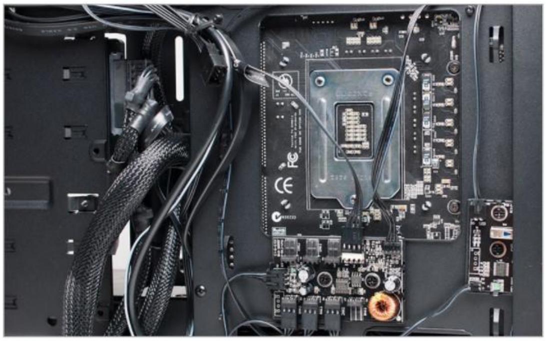


5

NOT SUCH AN UGLY SIDE

ASTONISHINGLY, THE MANTA accommodates cabling quite well, without the need for excessive tie-downs. If you look closely, you might notice that our big, fat power cables aren't actually tied down to anything. Instead, they sit in a channel that's beveled out into the motherboard compartment. Holes on either side of the channel offer access to the motherboard, while big cables have a roomy place to call home.

The backplate you see actually came from a Gigabyte H170 board. The Z170 board came with a backplate that had arms reaching out to each of the CPU cooler's mounting holes, with a threaded screw hole near the tip of each arm. The stock cooler's prongs couldn't be fitted into the threaded holes, so we had to go with another backplate.



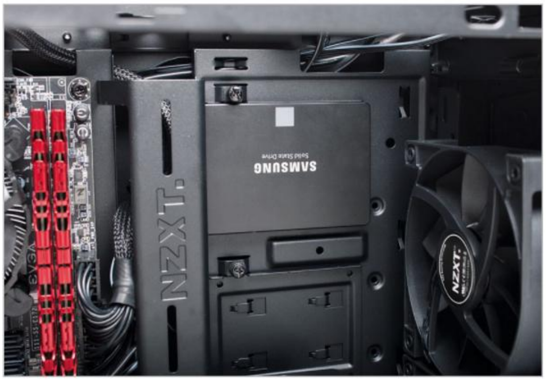
6

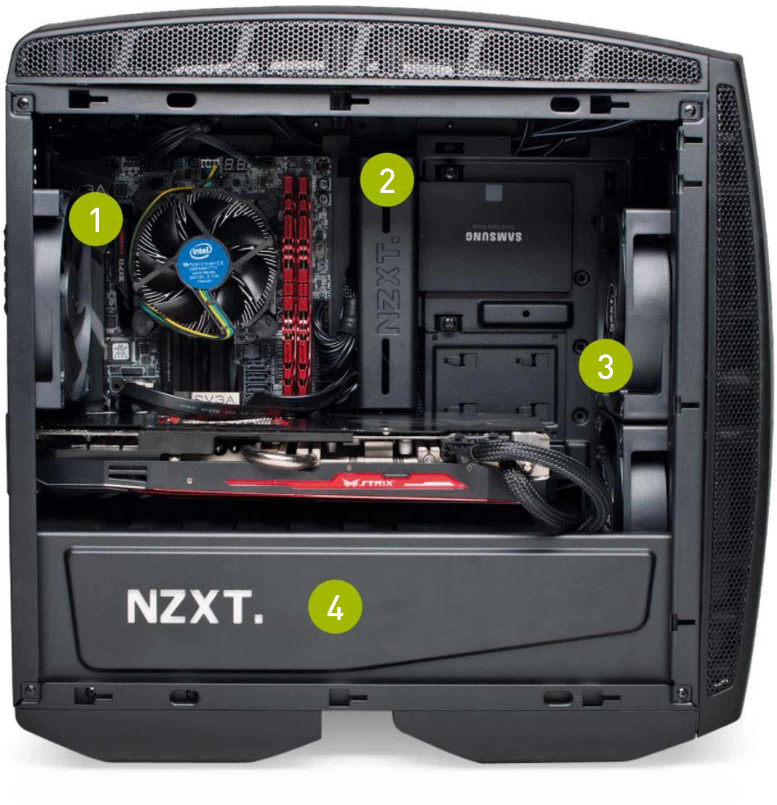
STEALTHY STORAGE

THE SAMSUNG 850 EVO we used for storage seems to disappear against the black interior of the Manta. We're just fine with this, because it offers a clean look and doesn't draw attention to itself right away. Upon casual inspection, one could wonder whether the system has storage at all.

The Manta has two mounts for 2.5-inch drives, which sit flush against the panel that's adjacent to the motherboard tray. Using a flush mounting position not only shows off the drives, but allows for an unobstructed path for air (or water tubing) to reach the motherboard.

If builders are looking for a place for a 3.5-inch HDD, the hard drive mount points are located under the PSU compartment partition.





1 We decided to mount the metal I/O connection cover (not to be confused with the back panel shield) for looks.

2 The cabling channel provides easy and clean cabling access to the motherboard and SSDs.

3 The Manta includes three fans (two up front, one rear) for plenty of airflow in a stock configuration.

4 A PSU partition helps keep the motherboard compartment looking clean and tidy.

PERFORMANCE IN AN ATTRACTIVE PACKAGE

PUTTING THIS RIG TOGETHER was fun, and we were happy with how it all worked out. The video card looks great behind the Manta's curved window, and the clean layout made the PC something to behold.

Looks aren't everything though, and at the end of the day, the PC has to perform. And perform it did, well, when it did.

There were several instances where the PC would reboot in the middle of a benchmark. While Windows 10 has annoyed users with silent updates and unprompted reboots, we thought it wouldn't happen in the middle of high CPU utilization. We did eventually get through all the benchmarks, so we let it slide. If this were going to be a machine that we'd use day-to-day, we would look for a firmware update for the mobo, and hunt down the culprit.

The scores from the tests were impressive. In our visual tests, the Fury happily pushed pixels out to our screen at a healthy rate, producing playable frame rates in the two 3840x2160 titles. At 1440p, the Fury managed to top 90fps, which is pure gold for gamers with 1440p screens. We're still not totally sold on gaming on 4K monitors; if you're planning on gaming, the smart money is that you're looking at 1440p performance.

In 3DMark Fire Strike Ultra, the Fury managed a score of 3,465. The Oculus Rift recommended spec has a score of 2,596, which easily puts this rig into Oculus-ready territory. Considering that the Oculus-recommended spec calls for an i5-4590 (with a higher clock speed than the i5-6500), we're happy with that.

When it came to timed benchmarks, the 3.2GHz quad-core wasn't going to keep up with the i7-5960X we use as a zero-point. The i5-6500 isn't the CPU you want for computational or workstation tasks, so music producers and graphics designers should go for an i7 instead.

We liked the doors on the Manta, as it had nubs that helped us align the door before securing it. However, NZXT opted for thumb screws that are meant to stay on the doors. While this is great to prevent loss, they assume awkward angles when you're trying to secure the door closed. Having removable screws would alleviate some of these problems.

The Manta is pretty, but it's expensive. The Phanteks Enthoo Evolv we used last month was $70, and offered room for full-size GPUs like the Manta. While the features of the two are different, and the Manta offers more cooling options, it is twice as expensive. It's better suited for builds that plan to do overclocking, so the cooling options can be put to good use. If you're staying stock and locked, the Enthooo Evolv might serve you better. ⏻

BENCHMARKS

	ZERO-POINT	
Stitch.Efx 2.0 (sec)	806	832 (-3.2%)
ProShow Producer 5.0 (sec)	1,472	1,811 (-23%)
x264 HD 5.0 (fps)	33.8	13.47 (-60.1%)
Batman: Arkham City 1440p (fps)	204	92 (-55.9%)
Tomb Raider 2160p (fps)	87.5	38.8 (-55.7%)
Shadow of Mordor 2160p (fps)	70.1	44.73 (-36.2%)
3DMark Fire Strike Ultra	8,016	3,465 (-56.8%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our desktop zero-point PC uses a Core i7-5960X CPU, three GTX 980s, and 16GB RAM. *Arkham City* tested at 2560x1440 max settings with PhysX off; *Tomb Raider* at Ultimate settings; *Shadow of Mordor* at Max settings.

72
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REVIEWS

TESTED. REVIEWED. VERDICTIZED.

INSIDE

72 Digital Storm Equinox
74 Dell XPS 15
77 NZXT Manta
78 Devialet Silver Phantom Duo
80 Zotac NEN Steam Machine SN970
82 Asus ROG Swift PG348Q
84 Corsair VOID Wireless Dolby 7.1 RGB Gaming Headset
85 Logitech G810 Orion Spectrum
86 Far Cry Primal
88 XCOM 2
91 Firewatch
92 Lab Notes

DIGITALSTORM

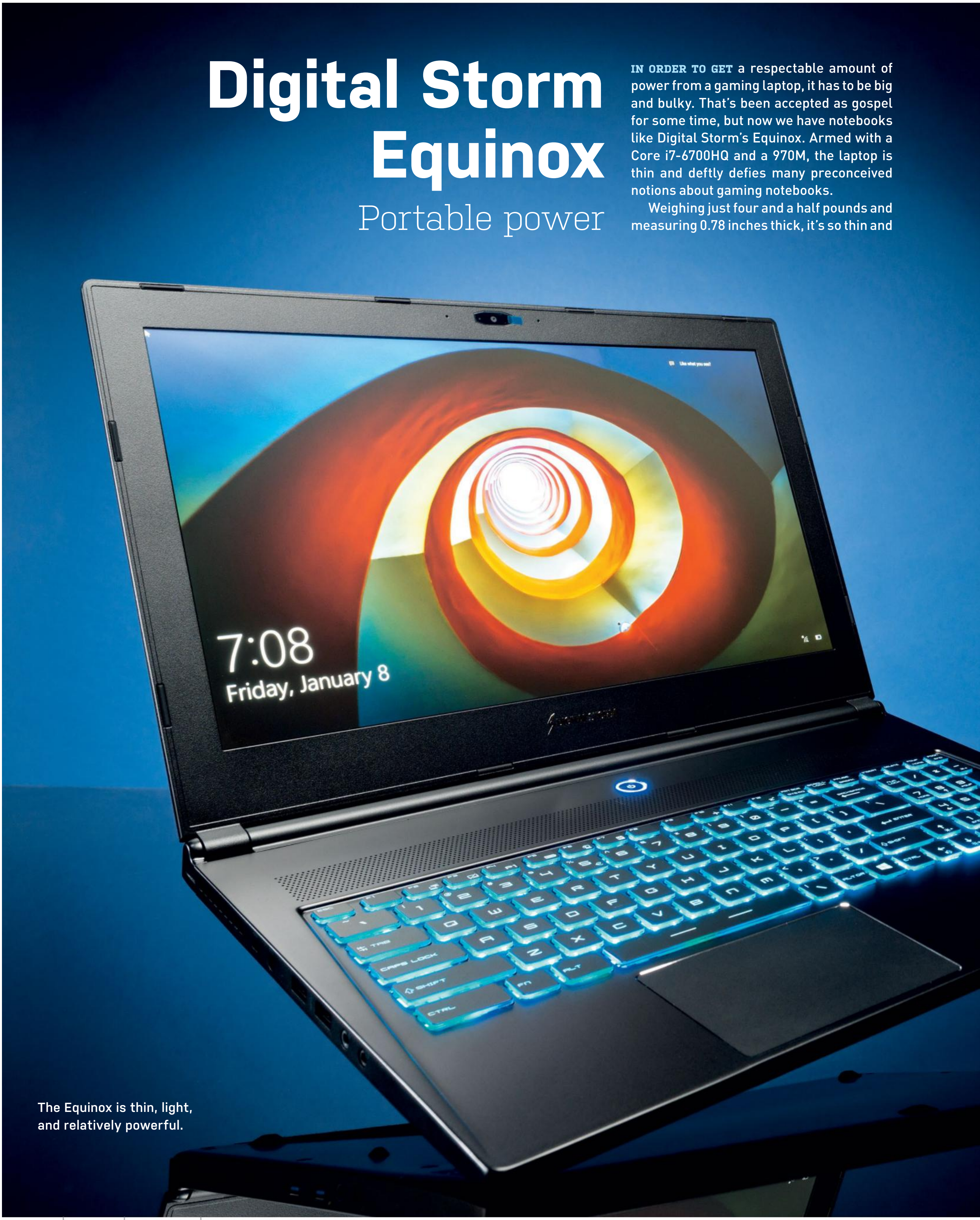
DIGITAL STORM EQUINOX PAGE 72

Digital Storm Equinox

Portable power

IN ORDER TO GET a respectable amount of power from a gaming laptop, it has to be big and bulky. That's been accepted as gospel for some time, but now we have notebooks like Digital Storm's Equinox. Armed with a Core i7-6700HQ and a 970M, the laptop is thin and deftly defies many preconceived notions about gaming notebooks.

Weighing just four and a half pounds and measuring 0.78 inches thick, it's so thin and



The Equinox is thin, light, and relatively powerful.

light that we thought the box was empty when we opened it. To be fair, the box that it shipped in is a little weird, and had some folders and other stuff covering the laptop, but still, that's pretty crazy. Aesthetically, we like the look of the notebook; it's simple and clean, and predominately black. It's much sexier than the big, bulky notebooks that we've grown accustomed to in the gaming genre. And its thinness doesn't mean the laptop is lacking in ports. The Equinox features two USB 3.0 ports, a headphone/mic jack, a USB C port, SD card reader, HDMI, and Mini DisplayPort. It's thick enough to just fit its Ethernet port, which is greatly appreciated for LAN events. It also uses a dual-fan thermal cooling design, and has both side and rear exhausts. Our only complaint about the chassis is that it's a fingerprint magnet.

Luckily, you won't mind getting your hands on the SteelSeries keyboard as it's competent and offers RGB keys with three different color zones. It does have an oddity that takes some getting used to, though, in the placement of the Windows button, which is to the right of the space bar. The trackpad, while equally competent, also takes a little getting used to because it's oriented slightly left of center. The laptop's speakers, by Dynaudio, are good, and offer decent firepower.

The 15.4-inch screen uses a PLS panel, which offers better viewing angles than most TN panels, but can't match the color accuracy of an IPS display. All in all, the 1080p matte panel is good, but not great. It's still capped off at 60Hz and there's no G-Sync support. In case you were wondering, the screen can bend back roughly 165 degrees, and has about a one-inch bezel around the display.

The laptop's specs are more impressive than the screen. Ours came with a 6700HQ CPU with 16GB RAM, and a GeForce GTX 970M with 6GB of VRAM, which is a lot of GPU horsepower for a laptop this thin. The Equinox didn't skimp storage-wise either—our unit came with a 250GB NVMe SSD, and a 1TB 7,200rpm HDD for mass storage.

TURNING UP THE HEAT

Performance-wise, the CPU gains were a mixed bag compared to our Alienware 14 zero-point laptop. It performed roughly even in our Stitch benchmark, about 10 percent better in our multithreaded x264 benchmark, but surprisingly lost by nine percent in our Proshow Producer benchmark. Things looked a lot more lopsided in the Equinox's favor when it came to GPU performance, where it bested our ZP by 94–200 percent. In short, you should be able to play the majority of games here maxed out at 1080p. We fired up *Rainbow Six Siege,* which is a moderately taxing game, and were able to garner average fps in the mid 60s. In the graphically demanding *Rise of the Tomb Raider,* however, we got around 30fps on low settings. Ouch! That stung quite a bit, but is perhaps more of an indication that the game isn't very well optimized. Still, this isn't a gaming desktop, nor is it using desktop components, so you shouldn't expect that level of performance here.

What you can expect, however, is a lot of heat and noise. When the Equinox is firing on all cylinders, it can be a bit warm and loud. Nothing extremely offensive, but it won't go unnoticed. Another downside of the laptop's thin design is that it doesn't have a huge battery, and died on us after the 120-minute mark, which is pretty bad.

Still, with a laptop this thin, you should expect some concessions somewhere, and the Equinox doesn't make too many of them. This laptop is quite powerful for what it is, and is extremely portable. It also offers a decent array of ports and is pretty sexy for a gaming notebook. At $2,000, it isn't cheap, of course, but you're paying for what you get here. Fortunately, what you're getting is great. **–JIMMY THANG**

VERDICT

9

Digital Storm Equinox

+ DIGITAL STORM Ultra slim and portable; relatively powerful; sexy aesthetics.

− DIGITAL APOCALYPSE Chassis is a fingerprint magnet; panel could be better; gets a little warm and loud; middling CPU performance; poor battery life.

$2,000, www.digitalstorm.com

SPECIFICATIONS

CPU	Intel Core i7-6700HQ @ 2.6GHz
RAM	16GB DDR4 @ 2,133MHz
Chipset	Intel Z170
GPU	Nvidia GeForce GTX 970M 6GB VRAM
Display	15.4-inch, 1920x1080 display (matte)
Connectivity	2x USB 3.0, headset and mic port, SD card reader, Mini DisplayPort, HDMI port, Ethernet port, USB type C
Storage	250GB SSD, 1TB HDD
Weight (Lap/Carry)	4lb, 5oz/5lb, 9oz

BENCHMARKS

	ZERO-POINT	
Stitch.Efx 2.0 (sec)	962	954 (0.8%)
Proshow Producer 5 (sec)	1,629	1,787 (-9.2%)
x264 HD 5.0	13.5	15 (10.5%)
Bioshock Infinite (fps)	36.1	117.7 (106.1%)
Metro Last Light (fps)	30.4	84.6 (94.2%)
3DMark 11 Perf	4,170	9,279 (199.8%)
Battery Life (min)	234	120 (-64.4%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our zero-point notebook is an Alienware 14 with a 2.4GHz Intel Core i7-4700MQ, 16GB DDR3/1600, 256GB mSATA SSD, 750GB 5,400rpm HDD, a GeForce GTX 765M, and Windows 7 Home Premium 64-bit. *BioShock Infinite* tested at 1920x1080 at Ultra DX11 settings; *Metro: Last Light* tested at 1920x1080 at DX11 medium quality settings, with PhysX disabled.

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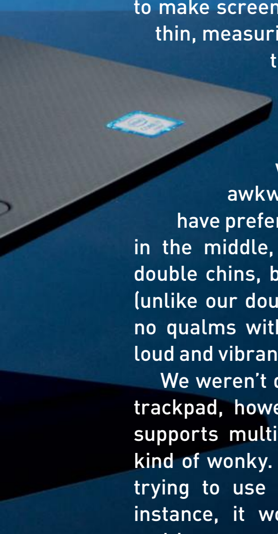
DELL

The 4K IPS monitor is simply a thing of beauty.

Dell XPS 15

Surprisingly, this is a gaming laptop



WHEN IT COMES TO LAPTOPS, 15-inch models are in that awkward space between super-sexy 13-inch Ultrabooks and 17-inch big-screen behemoths. Dell is trying to grab the best assets from both with its 2016 XPS 15, and it largely succeeds.

Dell calls its new XPS 15 "the smallest 15-inch laptop on the planet," but what makes it arguably sexier is that the company was able to squeeze a discrete Nvidia GPU into its 4.5-pound build. And this isn't some bottom-of-the-barrel mobile graphics card, either. The XPS 15 comes with a very capable GTX 960M, which, it turns out, makes this bad boy a competent gaming machine. At least at 1080p.

It might not look like a gaming notebook, but that's OK by us. Its aesthetics run along the lines of a slightly larger version of the XPS 13 Ultrabook we reviewed last year, meaning it's elegant and made of high-quality materials—specifically, CNC-machined aluminum, which does a good job of keeping the chassis fingerprint-free. Its palm rest also uses a carbon fiber composite, which has a nice soft touch to it.

Dell also knocked it out of the park with its 15.6-inch display. Our unit came with a 4K 3840x2160 resolution IGZO IPS panel, and it provides amazing color accuracy and a 170-degree viewing angle. The display boasts 350 nits of brightness, which gives it an amazing pop. Dell really knows how to make screens. The bezel is also super-thin, measuring roughly a fifth of an inch thick, which Dell has dubbed the "InfinityEdge."

Below the beautiful screen is a webcam, which is placed a little awkwardly to the left. We would have preferred it to be above the panel in the middle, to avoid showing off any double chins, but it's not a huge problem (unlike our double chins). Luckily, we had no qualms with the speakers, which are loud and vibrant.

We weren't quite as enamored with the trackpad, however. While we like that it supports multi-finger gesturing, it acted kind of wonky. Sometimes when we were trying to use two fingers to scroll, for instance, it would misread our actions and interpret them as a pinch and zoom. Worse, however, was when it read our right clicks as left clicks. The keyboard is less offensive, but isn't perfect. Dell says it features a 1.3mm travel distance, but it feels a bit mushy, especially the space bar.

Thankfully, the great internal specs do a good job of making up for the system's shortcomings. As mentioned above, our XPS 15 came equipped with a GeForce 960M, which lays claim to 2GB of GDDR5 VRAM. The laptop also features a high-end CPU in Intel's Core i7-6700HQ Skylake CPU clocked at 2.6GHz, and has plenty of RAM—16GB DDR4 memory clocked at 2,133MHz. Storage-wise, it packs a healthy offering in Samsung's 512GB PM951 NVMe SSD.

DELTA FORCE

When it came time to clean the house, the Dell XPS 15 mopped the floor with our zero point, which just happens to be Dell's Haswell XPS 13. In single-threaded tests, we saw roughly 19–40 percent gains. If that wasn't amazing enough, in our multithreaded x264 benchmark, we saw a huge 175 percent delta. But it was in the graphics benchmarks where the XPS 15 really pushed the pedal to the metal, beating the XPS 13's paltry integrated graphics by 407–525 percent! To be honest, the XPS 15 is more like a gaming laptop in an ultra-portable's form factor, so it isn't really a fair comparison.

In gaming, the XPS was able to max out games or run them on very high settings with smooth frame rates at 1080p. Playing *TF2* maxed out at 1080p, we garnered an fps average in the 170s, and in the Unreal Engine 3 game *Dirty Bomb,* we got an average fps that hovered in the 70s with everything maxed out. It did dip into the 50s every now and then, which is indicative of some of the limitations of the GPU. Still, in this form factor, that's mighty impressive.

At $2,230, all of this performance doesn't come cheap, but our build is the highest-end configuration, and if you want to save a few bones here and there, you can do so by picking parts more conservatively on Dell's website. What we can say about our unit is that aside from the keyboard and trackpad, this is a fantastic notebook for both work and play. **–JIMMY THANG**

VERDICT
9

Dell XPS 15

HOT Beautiful screen; gaming-capable laptop; all-around good design.

OVERHEATING Bad trackpad; mushy keyboard; awkward camera placement; poor battery life.

$2,230, www.dell.com

SPECIFICATIONS

CPU	Intel Core i7-6700HQ @ 2.6GHz
RAM	16GB DDR4 @ 2,133MHz
GPU	Nvidia GeForce GTX 960M 2GB GDDR5
Display	15.6-inch 3840x2160 IPS LCD
Connectivity	2x USB 3.0, HDMI, USB C, SD card slot, headphone
Storage	512GB NVMe SSD
Weight (Lap/Carry)	4 lb, 5 oz/5 lb, 4 oz

BENCHMARKS

	ZERO-POINT	
Stitch.Efx 2.0 (sec)	1,710	1,019 (40.4%)
Proshow Producer 5 (sec)	2,392	1,920 (19.7%)
x264 HD 5.0 (fps)	5.2	14.3 (175%)
Tomb Raider (fps)	24.9	155.7 (525.3%)
3DMark 11 Performance (index)	1,094	5,556 (407.8%)
Battery Life (min)	223	118 (-15.7%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our zero-point Ultrabook is a Dell XPS 13 with an Intel Core i5-5200U clocked at 2.2GHz with 8GB DDR3 RAM, running Windows 10 64-bit. 3DMark 11 was run in Performance mode; *Tomb Raider* was run using low settings.

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NZXT Manta

Meet the steely hammer of innovation

SAY HELLO TO NZXT's all-new enthusiast chassis, the Manta. It is, by far, one of the most sensual cases we've ever had the pleasure of reviewing. Yes, we know what you're thinking: It's big—too big for an ITX build. And it's true. At most, those sleek steel panels can only house a single GPU. But Bitfenix's Prodigy, although an outstanding case, also garnered abuse from ITX enthusiasts for being "far too rowdy" for a simple small form factor PC.

The thing is, ITX has evolved far beyond what it was initially designed to be. Today, you could, in theory, throw a system together with a Core i7-5960X, 32GB of DDR4, and a GeForce GTX Titan Z, overclock it to the sun and back, and still run it confidently in an ITX chassis. The point is, ITX systems are quite capable of providing everyone with a solid, dependable gaming machine or workstation.

NZXT has latched on to the idea, providing this particular demographic with a sorely needed bout of innovation. Over the last year, we've seen a plethora of ITX cases emerge for SteamOS, yet nothing for people looking to build a more traditional style of tower system.

The Manta is that striking of the hammer that we all needed—a design boasting a level of intuition the likes of which we haven't seen for some time. It's the first case featuring curved steel panels; the first ITX case showing off two SSD mounting points; and only the second ITX chassis to follow the traditional mid-tower design with a PSU cover (beaten to the punch by Phantek's Enthoo Evolv ITX). Couple that with the fact that you can fit in two 280mm radiators and, well, we're (almost) lost for words.

FANTASTIC FEATURES

So how does it work for the first-timer? Well, if you're looking to build a quick and clean reference build, it's a dream. Couple this chassis with a reference GPU, an AIO cooler, a custom cable kit, and a sexy looking motherboard, and you'll find it tremendous fun to build a stunning, clean, gaming PC. The cable management room in the back is plentiful, and thanks to the bowed steel rear panels, you can easily fit a 3.5-inch HDD on the opposite side of the two SSD slots as well. There's also an additional sound-dampened mounting point next to the power supply for your choice of 2.5-inch or 3.5-inch hard drive. The bottom PSU cover hides all your unwanted cables for those using non-modular power supplies, and the cable bar—taken from the NZXT Source 340—hides the rest of those connectors, while also serving as a reservoir mounting point.

Thanks again to the bowed front and top panels, you can install push/pull in the front, and mount the fans above the chassis in the roof, allowing space for that 280mm rad. The dust filters clip into place, and the one below the power supply is magnetic, to make doubly sure it won't fall off. Overall ground clearance is good—we're looking at 1.5 inches or so, with rubber padded strips for feet to absorb any unwanted vibrations.

Other neat features are the fan hub hidden behind the motherboard, the rear I/O LED, and that swanky white LED NZXT logo across the side of the PSU cover.

The Manta isn't perfect, though. Most modern ITX motherboards are designed to be installed horizontally, compared to traditional ATX boards, so their 24-pin and 8-pin power connectors tend to be located all over the place. You'll have to make doubly sure when speccing your build to take a good look at motherboards, and find one that suits your cable management.

Ultimately, those curved steel panels, the gorgeous side window, the stunning matt black finish, and the fantastic array of nifty design features make building in this chassis an absolute pleasure. It looks good, and despite the small problem of finding a decently compatible motherboard, all in all it's a phenomenally well designed chassis. A true modern masterpiece. Definitely worthy of our Kick Ass award—and then some. **–ZAK STOREY**

VERDICT
9
KICK ASS!

NZXT Manta

+ MANTA RAY Curved steel; great finish; intuitive design; integrated fan controller; good price; huge window; rear I/O LED.

− FLOPPY FISH Pricey, ITX motherboard cable management can be tricky.

$140, www.nzxt.com

SPECIFICATIONS

Form Factor	ITX
Dimensions (W x H x D)	9.6 x 16.8 x 17.7 inches
Cooling	Front: 2x 120/140mm Top: 2x 120/140mm Rear: 1x 120mm
CPU Cooler Clearance	6.3 inches
Graphics Card Max Length	14.3 inches
Storage Support	3x 2.5-inch 2x 3.5-inch
Power Supply Support	ATX

How much for a pair of speakers?

Devialet Silver Phantom Duo

The best speakers you've never heard of

BULGING EYES, GAPING MOUTHS, peers turning for double-takes, and sometimes even looks of confusion: That was our observation of facial reactions when testing Devialet's Silver Phantoms in the *Maximum PC* office. Describing audio performance is difficult. Should we wax poetic about how something sounds? Words such as air, stage, warm, smooth, rich—they don't really mean anything. So perhaps a good descriptor would instead be how people react when they hear it.

The Phantom is a speaker designed by French outfit Devialet. Haven't heard of it? That's OK, we hadn't either. Unless you're inside specific circles of the audiophile community, Devialet is a name few will recognize, but it's revered for designing amplifiers for loudspeakers that go against conventional design principles.

About the size of two toasters, the Phantom looks anything but conventional—maybe more like an alien probe. But Devialet is adamant that despite its size, the Phantom can replace a hi-fi system costing $20,000 or more. And if you asked anyone who's listened to the Phantoms, you might start believing so, too.

There are three main technologies in the Phantom: speaker active matching (SAM), analog-digital hybrid (ADH), and heart bass implosion (HBI).

Let's start with SAM. Devialet measures movements of a speaker driver with lasers, then uses the information to mathematically map the driver. The result is speaker movement that's precisely controlled, no matter what the volume is set to or what the audio content is. For Phantom, Devialet says it's able to play at maximum volume without distortion and without loss of fidelity. In other words, the Phantom sounds awesome at all levels.

ADH is how the Silver Phantom delivers 3,000 watts of power. Using a combination of Class A and Class D amplifiers, the Phantom can dish out 105dB of sound pressure—enough to rock an entire nightclub. High-end speaker amps often employ Class A designs because the fidelity is high. The drawback is that Class A amps run hot due to inefficiency. This is where Class D amps come in—they're highly efficient and powerful, but they lack fidelity. With ADH, Devialet combines both technologies to produce powerful—extremely loud—and clean audio.

Then we come to the final, and arguably most impressive, technology: the HBI system. It's the two fisheye drivers on either side of the Phantom, which are responsible for bass. And what glorious bass the Phantoms produce. Frequency responds down to a mind-boggling 16Hz. In case you're wondering, this is low—lower than most home theater subwoofers could ever dream of going. Humans can hear down to 20Hz, but the Phantom's bass extension drills down to subsonic levels. Yes, you can feel the Phantoms.

"I've got a massive subwoofer with a 16-inch driver that can do that," you say?

Great! Except, the Phantom is only six liters in volume—compare that with your monster 100-liter subwoofer. If you've got a smaller sub or large floor-standing speakers, the Phantom will punch a hole through the floor and bury them.

This is where we get to the head-scratching reactions of listeners. Everyone, and we mean everyone, gawks in awe as the Phantom plays. They ask questions such as, "How is that thing making that kind of sound?" Or simply, "What the *@#$?!"

The Phantoms simply defy conventional speaker design principles. To deliver really low frequency extension at good volumes, a speaker cabinet needs to contain volume because lots of air mass needs to be moved. This is precisely why subwoofers that have very low frequency responses need to be designed large. Forget the subwoofer that came with your PC desktop; those aren't what we'd consider real subwoofers.

The Phantoms sound good with all genres of music, as well as movies. The real test is playing tracks with deep bass. More often than not, when speakers are cranked up, the bass will wreak havoc on the rest of the audio spectrum. Mids become unclear and highs are drowned out. Not so with the Phantoms. Here, SAM works so well that we perceived no dips in frequency response. Without using expletives—and believe us, we want to—the Phantoms are simply jaw-dropping.

What about stereo imaging? The problem is, you need two Phantoms to produce stereo. You can buy one Phantom, which still sounds phenomenal and has no issues filling large rooms, but it'll only operate in mixed-mono mode. To get stereo, you'll also need to purchase Devialet's Dialog, which is a wireless control unit that the Phantoms connect to wirelessly. In fact, the Dialog can control up to 24 individual Phantoms—one for each room of your mansion.

There are two models: the vanilla Phantom, which is white, with 750 watts producing 99dB, and the Silver Phantom. The Silver dishes out 3,000 watts at 105dB. Lest there be any doubt, 105dB is the legal limit for a club.

We've demoed the Phantoms to about 18 people now. All their reactions have been the same: mind-blown. The cost of this experience? $2,390 for one Silver Phantom, and double that for two, with an added $329 for the Dialog. So, at just over $5,100, can the Phantoms replace our multi-thousand-dollar home theater system? No. They destroy it. **–TUAN NGUYEN**

VERDICT
9
KICK ASS!

Devialet Silver Phantom Duo

+ PROS Unbelievable audio quality; deep, punchy, tight bass; incredible sound stage; shockingly small; $5,100 for $20,000-worth of sound.

– CONS Pricey; ugly yellow power cord.

$5,109, http://devialet.com

Zotac NEN Steam Machine SN970

Zotac's latest Steam Machine is a good workman let down by its tools

REMEMBER WHEN we thought Steam Machines were a pretty neat idea? Remember when Valve was going to save us from the PC gaming hegemony—nay, dictatorship—of the evil Microsoft? Yeah! Things haven't really worked out that way, have they? In fact, the more time we spend with Steam Machines, and their Linux-lite OS, the more glorious the homecoming when switching back to Windows.

It's the same situation with Zotac's latest Steam Machine, the bizarrely titled NEN,

It's close to being the perfect PC console.

which is a damned shame, because Zotac has created one of the most impressive mini-rigs we've ever tested, cramming full-size gaming hardware into an almost pint-sized package.

For a start, the black and white, Stormtrooper-inspired design is seriously pleasing. But it's what's inside that counts. Within that diminutive exterior is a Skylake quad-core CPU, the 35W Core i5-6400T. Backing up the impressively solid processor is 8GB of DDR3 memory, running at 1,600MHz, though the NEN's memory system is made up of just one SODIMM, meaning that it's only running in single-channel mode.

Still, it offers a little upgrade potential in the future—though there are far more immediate upgrades you're going to need to engage in to get the most out of Zotac's NEN. But we'll come to that in due course.

The big attraction of the NEN, though, is its graphics power. Trapped inside that black and white vented plastic trim is a full desktop GTX 960, with enough passive cooling and power management to maintain operation in a small chassis without needing a hulking, whining turbine of a fan keeping things chilled.

Even at full tilt in-game, the NEN remains remarkably softly spoken. That's vital for a small gaming PC, which has its sights set firmly on the big-screen TV in your living room, rather than the desktop of your home office. You don't want a lounge-based machine roaring away in the corner every time you boot up a game of *XCOM2* to have your ass handed back to you by a ravening alien horde. Otherwise, it's just plain distracting.

OS SHACKLES

But if you want to get the absolute most from the performance hardware Zotac has jammed inside the NEN Steam Machine, we need to have a quiet word about SteamOS. And by "quiet word" we mean "lead the dumb beast out into the yard and put a shotgun in its mouth."

The pre-installed Linux-based OS had so much going for it. It can essentially turn this mini gaming rig into an easily accessible living room console by booting directly into Steam's Big Picture Mode. With the bundled Steam Controller, you don't even need a mouse and keyboard to interact anymore. Sure, the controller is something of a plastic monstrosity, but it'll do in a pinch.

From Big Picture Mode, you should have access to all your Steam games, with the ability to play each and every one from the comfort of your sofa; a luxury hitherto only afforded our console-class brethren.

Except you kinda don't. There is still a dearth of native SteamOS games, and although the number is undoubtedly growing, there's no getting around the frustration of searching through your games library, having to skip over the vast majority that won't run on your new $900 gaming machine.

The final nail, though, is that you would get far greater gaming performance with a Windows installation, even if you do find a game that's SteamOS compatible. In extreme cases, the frame rate halves, but across the board in our benchmarks, the NEN dramatically slowed when running the ropey Linux hardware drivers.

SteamOS really is the limiting factor here, though with a Windows install, Zotac's otherwise seriously impressive NEN hardware runs like a dream. It is, however, another $100 software upgrade to gain access to the full performance this little gaming rig is capable of. **–DAVE JAMES**

VERDICT 8

Zotac NEN Steam Machine SN970

+ STEAMY Impressive scale; serious performance; whisper-quiet.

− STEAMING PILE SteamOS limits game library... and hardware performance; a Windows 10 update is another $100.

$900, www.zotac.com

SPECIFICATIONS

CPU	Intel Core i5-6400T @ 2.2GHz (2.8GHz Turbo)
Memory	8GB single-channel DDR3 @ 1,600MHz
Storage	1TB HDD
Graphics	Nvidia GTX 960 2GB GDDR5
I/O	Wi-Fi 802.11ac/b/g/n, Bluetooth 4.0, 2x Ethernet, 2x USB 2.0, 2x USB 3.0, 1x USB-C, 4x HDMI 2.0
Dimensions	8.3 x 8.0 x 2.4 inches

BENCHMARKS

	ZOTAC NEN SN970 *(WIN 10)*	ZOTAC NEN SN970 *(STEAMOS)*
Company of Heroes 2	29	14 (-51.72%)
Shadow of Mordor	54	41 (-24.07%)
Talos Principle	56	51 (-8.93%)
Total War: Attila	28	15 (-46.43%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

All the games were tested at 1920x1080, at peak settings, with 4x antialiasing where available. We used an installation of Windows 10 64-bit to provide a zero-point alternative to SteamOS.

Asus ROG Swift PG348Q

Is this the pinnacle of LCD panels?

ONE DAY in the distant future (well, about five years from now), we'll look back at LCD monitors with both wonder and horror. Just as it now seems odd to think passenger jets were once full of people puffing away on cigarettes, soon the notion of shining light though millions of tiny shutters will be ridiculous. What were they thinking?

But that day will also give us the perspective to identify the pinnacle of LCD technology. Peak LCD, you could call it. And the Asus ROG Swift PG348Q might be it.

The point is that LCD is a dumb idea for a full-color digital display. Remember, it's a grid of microscopic shutters that attempts, imperfectly, to control the transmission of light from a rear-firing backlight. There is always some leakage. And that leakage varies depending on your vantage point, causing all kinds of viewing angle issues. What's more, the twisting, turning liquid crystals inside those shutters are always going to be relatively slow to respond.

And yet the Asus ROG Swift PG348Q is testament to human ingenuity, because it's simply beautiful to look at, and achieves things with LCD that should not be possible. That's thanks to a roll call of snazziness that checks pretty much every box. The panel is the latest-gen IPS wizardry, in 34 inches with a super-wide aspect ratio, 3440x1400 pixels, and 10-bit per channel color. And it's curved for that wrap-around feel.

It also supports a maximum refresh of 100Hz and Nvidia's G-Sync cleverness. So that's IPS, curved, high-res, super-wide, high refresh, and adaptive sync in a single screen. On paper, it's messianic stuff, the monitor we've been waiting for. And so it proves in practice.

CAUTION: EXPLOSIVE

The colors don't just pop, they explode. The viewing angles are as good as we've seen. Even the black levels are great, and there's none of that nasty IPS glow. Fire up some test images and you'll find immaculate gradients and really impressive calibration out of the box. With 4ms response times and configurable pixel overdrive (even the fastest setting only introduces a whiff of inverse ghosting), it's seriously nippy, too.

The overall upshot is a screen that looks outrageous, whether you're sauntering through the evening sun in a great-looking game such as *Witcher 3*, or playing HD video content. On that note, 1440p and 4K content are out of this world on the Asus. It's worth noting, also, that while the 100Hz refresh isn't a match on paper for the fastest 144Hz monitors, you'd be hard-pressed to see the difference. It's a mean-looking machine, too, thanks to a stylized chassis, and an LED light that projects an ROG logo on to the surface below the stand.

If you're looking for downsides, the swanky design obscures inconsistent build quality, the LED mood lighting is silly, and the claimed "frameless" design merely translates into a slim bezel. It's also true that, for some, the benefits of G-Sync and adaptive-sync technology are marginal. But the real stumbling block will be price. At well over $1,000, it's serious money.

Arguably, screens are the one PC component that makes sense as a long-term investment. With the first OLED monitors appearing, suddenly we're doubting the sense of dumping big money on LCD technology. But if you're happy to do that in the knowledge that OLED will very likely revolutionize PC displays over the next few years, this Asus is probably as good as it currently gets. –**JEREMY LAIRD**

VERDICT

9

Asus ROG Swift PG348Q

⊞ **MESSIAH** Gorgeous IPS panel; kitchen-sink feature set; funky design.

⊟ **NAUGHTY BOY** Hideously expensive; OLED tech is incoming.

$1,299, www.asus.com

SPECIFICATIONS

Panel Size	34-inch
Native Resolution	3440x1440
Panel Type	IPS, 10-bit
Maximum Refresh	100Hz
Response	4ms
Contrast	1,000: 1
Inputs	DisplayPort, HDMI
Warranty	Three years

Operation First Sword
OBJECTIVES:
Hack the Workstation on ADVENT Train
DIFFICULTY:
Easy
REWARDS:
101 Intel
Assault Rifle
PRIMARY WEAPON
Increase Squad Size through the G.T.S facility.
CORPORAL
MORENO
RANGER
G-SYNC

Assault Rifle
PRIMARY WEAPON
SQUADDIE
CLARK
SPECIALIST
Sniper Rifle
PRIMARY WEAPON
CORPORAL
HALVORSEN
SHARPSHOOTER
Assault Rifle
PRIMARY WEAPON
CORPORAL
WARD
SPECIALIST
Increase Squad Size
through the G.T.S facility.
MAKE UTILITY ITEMS AVAILABLE
MAKE ARMOR AVAILABLE
BUILD ITEMS
LAUNCH
MISSION
ASUS
01-800

The PG348Q boasts pretty much every feature you could want in a monitor.

Corsair VOID Wireless Dolby 7.1 RGB Gaming Headset

Intriguing design, needs refinement

WIRELESS HEADSETS are both loved and loathed by the PC enthusiast community. Losing the cable is great—it gives you the freedom to move around, and not get tangled up as your sudden bouts of rage take hold while wiping on that particularly annoying raid boss for the 18th time. On the other hand, they're battery-dependent, the quality and comfort can be lackluster, and eventually they're going to go flat. They're still an incredibly popular headset choice, and one Corsair is attempting to reinvigorate with its brand-new lineup of VOID RGB wireless gaming headsets.

Out of the box, our VOID was lightweight and comfortable. The circumaural ear cups fitted well enough to begin with, although they did feel a little loose around the lugs; there just wasn't enough tension on the underside of the cups themselves. The build quality is good—its predominantly plastic body hides a strong aluminum band running along the top of the headset. And the padding is soft and cushiony; it's not memory foam or anything of that ilk, but in our experience, that's a positive, as over time, memory foam loses its elasticity, and it's not long before your head is resting on bare plastic. The adjustment range is good, with both ear cups capable of swiveling up to 90 degrees, and the headband is more than roomy enough for even the largest of skulls—it's quite easy to get these to sit comfortably on the old noggin.

As for sound quality, it's what you'd expect from a USB headset, as that's predominantly what this is. And for the price, we're impressed. The soundscape is crisp and bouncy, there's a fraction of sibilance once the volume's turned up to the higher echelons, but all in all, it's really good. The bass is well rounded, too, and what you'd expect from a dynamic driver. Of course, you don't have the absolute range of something like Audio-Technica's ATH-M50X, but it's still good fun. You can always jump into Corsair's Utility Engine and change the EQ to "Clear Chat," because this adds a little more clarity to the upper mids and lower trebles, while reducing that gamey bass we've all come to hate.

ALL OF THE LEDS

The mic is another story. The quality is great, recordings sound precise and accurate, but the fact it's not adjustable is a little off-putting. Noise canceling isn't great, but it's not terrible either. On the other hand, the LED display included in the mic—aptly named Infomic—to notify you of particular events, or whether you're muted, well, that just seems a bit gimmicky to us. The fact is, it's just too close to your face for your eyes to even focus on it, yet even if you could, when the mic is positioned correctly in front of your mouth, the light actually faces away from your line of sight. And the only way to see it is either by bending the mic toward your face or placing your hand in front of it, which seems a little counterintuitive for a design feature that's meant to be hands-free.

And finally, we come to the large, bulbous elephant prancing merrily around the room: RGB LEDs. We'll admit, these are probably one of the better iterations of headset RGB lighting, as they're discreet and out of the way—not huge LED lasers draining your battery life to oblivion—however, they still fall prey to that one colossal problem unique to headsets: You can't see them.

For the money, the Corsair VOID RGB Wireless is a fine gaming headset. The range is great, the soundscape dependable, and overall comfort and fit are pretty good. There are still questions that need to be answered—Infomic and RGB LEDs being among them, and the sound leakage is something else. But all that aside, they're a joy to use. –**ZAK STOREY**

VERDICT

8

Corsair VOID Wireless Dolby 7.1 RGB Gaming Headset

+ VOID SPAWN Good sound quality; comfortable; intuitive design; looks good; well priced.

− VOID CONTRACT Infomic is odd; RGB LEDs; non-adjustable mic; leaky.

$130, www.corsair.com

SPECIFICATIONS

Driver Technology	50mm dynamic
Frequency Response	20Hz–20kHz
Impedance	32 ohms
Connectivity	USB, wireless
Microphone	Unidirectional noise-canceling
Battery Life	Up to 16 hours

Logitech G810 Orion Spectrum

Simple clean lines, simple clean keys

YOU KNOW WHAT WE LOVE? Manufacturers who listen. And that's exactly what Logitech has done. If you've been following *Maximum PC* for some time, you'll know that we reviewed the G810's older brother a few issues back. The G910 was Logitech's first entry into the world of custom mechanical switches—in the form of the Romer-G—and it came with all the bells and whistles you'd expect from the maker of the legendary G15 gaming keyboard.

But the G910 wasn't perfect. It catered to one demographic only: gamers. The key caps were indented, the macro keys abundant, and the stylization audacious and pointy. Couple that with fixed Logitech LED logos and media keys, and it almost felt like a wasted experience using that RGB lighting. It was a solid keyboard, but its "out there" design simply didn't appeal to us as much as the clean lines on Corsair's K70. If you were really into gaming, though, it was damn near perfect.

It's with a sigh of relief that we say that the G810 Orion Spectrum addresses almost all of the issues we had with the G910. All the LEDs on board can now be swapped out in unison, the design is simple, graceful, and clean, and those pesky macro keys are long gone. What you get is a good-looking mechanical keyboard.

Speaking of keys, the Romer-G is an interesting little number. Logitech has forsaken the Germanic factories of Cherry in favor of its own custom-designed switch. What's different about it? Well, it has an incredibly low travel for a mechanical switch, even less than a Cherry MX Red. Its actuation point is 25 percent less than that quintessential gaming switch, registering at 1.5mm, and each key is guaranteed for up to 70 million keystrokes, just to reassure you. If you look under the keycap, instead of the usual actuation cross that you find under the likes of Cherry or Razer's switches, you're greeted by a hollow centered switch, with an interesting-looking gauze covering the middle. What this does is diffuse the light across the entirety of the switch, creating a single color in the process.

What's it like in use? Well, it's a little unnerving typing on something so fast. It unmistakably still feels like a mechanical switch, yet the low actuation point isn't as satisfying as the longer travel can be on one of Cherry's masterpieces. The signature sound is there, but at a much lower volume than before. What that does is make this keyboard fantastic for the office, or a home environment, especially if you're surrounded by family. However, if you're a purist, accustomed to Cherry's vast arsenal of switch types, you may want to give this keyboard a chance in the flesh first before committing to purchasing it.

SOFTWARE OF THE FUTURE

It would be remiss of us not to talk about Logitech's new gaming software here. Over the last couple of years, it's come one hell of a way, and with the launch of the G810, design ideas and concepts have been pushed even further. Beyond the assortment of LED features we've all come to expect, you can also set select key binding profiles for each game. These automatically activate and change the profile as soon as you open up that EXE file. And if your game isn't on the list? You can add it—no sweat. On top of that, there's a nifty little heatmap mode that tracks exactly which keys you use most. We also have it on good authority that DK support will be added soon, meaning we might see some custom LED lighting utilities in-game, such as ammo count, health warnings, or even music equalizers.

Ultimately, this keyboard has taken all of the problems we had with the Logitech G910 and nicely smoothed them over, without losing too much in the process. The dedicated media keys are still there, the stunningly smooth Romer-G mechanical switches are there, the RGB lighting is there, and—more importantly—the design is absolutely on point. The downsides come in the lack of a USB passthrough or a wrist rest, but other than that, there's not a lot we can criticize about the G810 Orion Spectrum. **–ZAK STOREY**

VERDICT
9

Logitech G810 Orion Spectrum

➕ **SPECTRE** Intuitive switch; quiet; aesthetically pleasing; strong software support; full RGB LEDs; dedicated media keys.

➖ **HALLOWEEN COSTUME** No wrist rest; no USB passthrough.

$160, www.logitech.com

SPECIFICATIONS

Switch	Logitech's Romer-G switch
Connectivity	None
Size	16.0 x 7.5 x 1.4 inches
LEDs	Individually lit RGB 16.8 million colors
Macro Keys	All of them
Matrix	100% anti-ghosting; 26-key rollover

Sayla likes to cut the ears off enemies. Better do as she says.

Far Cry Primal

Lots of rock but not much roll in Ubi's Stone Age world

UBISOFT HAS MADE its game again. Publishers, and possibly players, love a franchise, and this installment of the open-world slaughter-'em-up takes us back 9,000 years before the invention of gunpowder, and 6,500 years before the wheel, for a Stone Age *Far Cry* without guns or vehicles.

When *Blood Dragon* followed *Far Cry 3,* it retailed for a budget price; this is a full release not tied to *Far Cry 4,* yet it shares a great deal with that game, showing that any time period can be stretched across its framework like skins at a tannery, only without the smell of urine—although you might catch your pet wolf disrespectfully relieving itself on the corpse of an enemy.

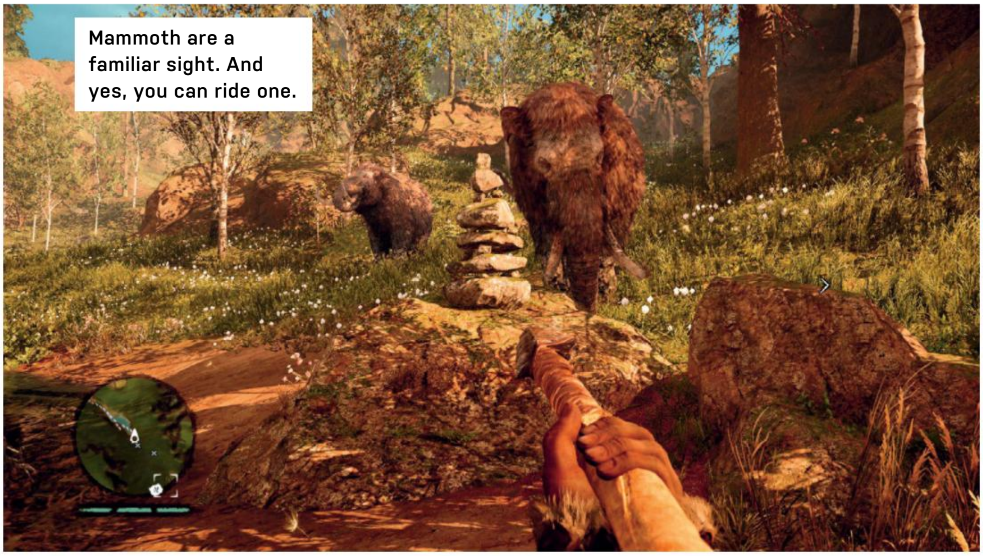
Animal taming is the big feature of *Primal.* Protagonist Takkar is trying to rebuild his tribe, the Wenja, in a land called Oros (in what's now Central Europe), populated by copious wildlife and a couple of other bands of humans. The Wenja should have died out, being the weakest tribe in the valley, but it transpires they're the ancestors of JK Rowling's wizards, while the others evolve into muggles. Takkar has a magic vision mode that displays nearby points of interest, such as footprints, beasts, and crafting materials, and he can also talk to the animals, making them into followers who obey his commands. In this way, he can be upgraded so he sees like an owl, hears like a lion, and smells like a badger.

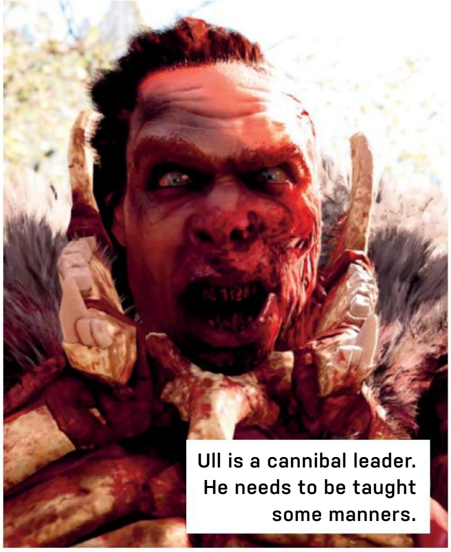
A wide range of nearby beasties can be brought under your control, and re-summoned when they die. Set-piece hunts (think Kyrat Fashion Week) net you more powerful companions, while upgrades in the skill tree increase their potency. You need these as you progress, particularly as later boss fights involve large health bars.

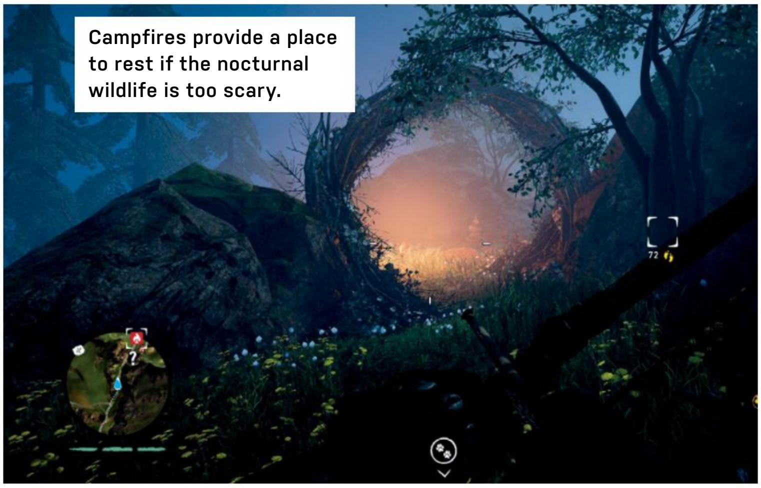
The familiar "Ubisoft rash" of mission icons spreads across the map, which is smaller than *Far Cry 4's* but densely packed with things to do. Radio towers are now bonfires, which must be captured from their current owners, rather than climbed. Outposts are pretty much the same, with a mix of enemies, caged animals, and often a sneaky way in. An arrow to the face still kills an enemy reliably and quietly, but stealth is more difficult in a game that limits your ranged weaponry so much. Luckily, the wild nature of the world means there's always plenty of cover, and crouching also reins in your active pet to lessen the chances of it giving you away—although it's often better to dismiss it and summon it back when you've been discovered, especially if you favor a bear, which has a low stealth rating.

Oros has no verbose, giggling dictator to worry about, although there is a sexy psycho predecessor to *Far Cry 4's* Noore, and forts to invade containing named characters. The land needs to be conquered by building up your village and increasing its population. You're ostensibly the chief, as it seems to be up to you to do everything, but a gatherer called Sayla is really in charge, sending you on missions and warning of attacks.

It's a land where predatory animals roam in packs, especially at night, when you can carry a flaming torch to scare off attackers and kindle further fires. There are a great many ways to die in *Primal,* but the wildlife is as dangerous to your enemies as it is to you. We crouched in the long grass and watched a pair of bears wipe out a gang


Mammoth are a familiar sight. And yes, you can ride one.


Ull is a cannibal leader. He needs to be taught some manners.


Campfires provide a place to rest if the nocturnal wildlife is too scary.

Lighting bonfires opens up fast travel abilities.

of rival cavemen without us needing to bait them into it. Some things haven't changed: We were butted to death by a boar, badgers are as tenacious as ever, and eagles still descend from the sky to ruin your day.

PRIMAL SCREAMS

Something else that hasn't changed is the universally reviled escort mission that appears dishearteningly early. At least those you're escorting are capable of defending themselves this time, but it's enough to make your heart sink. Ubisoft's Dunia 2 engine is still capable of displaying a beautiful, realistic world, especially if your GPU has a 9 in its name, and you can enable VSync to avoid the constant tearing. The physics engine has retained its tendency to send objects and bodies sliding down the gentlest of slopes, too.

The river valley the Wenja make their home in is verdant and lush, airborne seeds float through the air in the daytime, while at night the silvery spread of moonlight plays through the branches. Character faces have received the same attention, their eyes shining and their gestures graceful—it's a shame you're forced to look at the subtitles to understand their Stone Age language.

The Mesolithic setting proves to be a way of adding characters who wear animal parts on their heads and chant, without being accused of racism, so that the publisher can get rid of the absurd "work of fiction by a multicultural team" disclaimer that appears at the beginning of so many of its games. The choice of time period is an effective one, however, because once the novelty has worn off, it manages to distance itself from previous games in the series enough to keep your interest.

What makes us a bit sad is that the game isn't set on the wrong side of the Atlantic. North American megafauna were far better than their European counterparts—we could be riding a glyptodon into battle, or discovering a short-faced bear with a 14-foot reach at the back of a cave. The saber-toothed cats would have been bigger and the mammoths just as plentiful. Giant ground sloths! Steller's sea cows, 30 feet long, frolicking in the seas! Titanis walleri! We might be out by a few million years on that last one, but we can dream.

Primal's systems are familiar, but this helps the game sell its unusual setting—it can be hard to care about this tribe, and the game takes a while to get its teeth into you. *Far Cry* has always tried to show that man is the greatest monster (except possibly the first game, whose invisible mutants with machine guns came close), and *Primal's* embodiment of the noble savage archetype shows this very clearly. **–IAN EVENDEN**

VERDICT
7

Far Cry Primal

⊞ **AX MAN** Gorgeous graphics; really creative ideas; brutal melee combat.

⊟ **TAX MAN** Over-familiar systems; doesn't make an instant connection.

RECOMMENDED SPECS Intel Core i7-2600K, AMD FX-8350, or equivalent; 8GB RAM; Nvidia GeForce GTX 780, AMD Radeon R9 280X, or equivalent.

$60, http://far-cry.ubisoft.com, ESRB: M

Robotic Sectopods return to tower over your troops.

XCOM 2

When life gives you Mutons, make with a grenade

FOR ANYONE WHO thinks they're good at *XCOM,* Firaxis has a massive plasma cannon ready to blow your confidence apart. Just as glorified expansion pack *Terror From the Deep* was more difficult than the original *XCOM: UFO Defense* in the mid-nineties, so *XCOM 2* ups the challenge after 2012's *Enemy Unknown.*

It's harder for a different reason, though. This is the *XCOM* formula deconstructed and reassembled around the solid core laid down in the first game. No matter what happened in *Enemy Unknown,* this game assumes you lost. Twenty years after the events of the first game, Earth has been taken over by a collaborationist regime known as ADVENT, whose semi-human troops are infused with alien DNA. Citizens live in gleaming cities and drive futuristic cars, apparently unaware of the nefarious plots being hatched by their new masters.

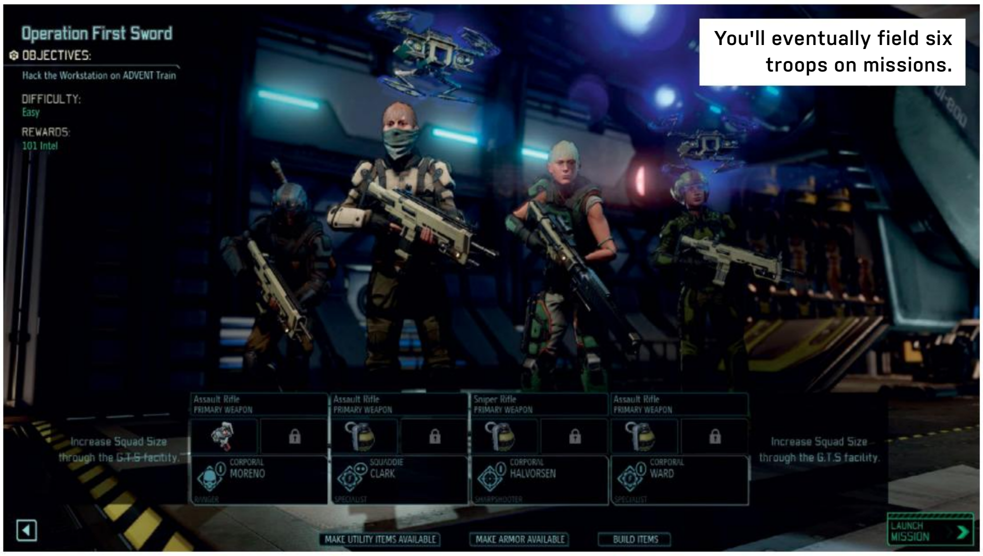
The alien soldiers and robots themselves have been improved, with taller, glistening, naked Sectoids looking very happy about mind-controlling your troops, while the Thin Man's wife comes out to play in the form of the Viper, an irritating reptile that can pull troops out of cover, and sports a positively mammalian decolletage. The entire bestiary is new or upgraded; only the Mutons march on much as they did before, and even the lowliest can be a major pain in the ass if it manages to flank your squad.

In recasting XCOM as a guerrilla resistance movement working against an entrenched occupying force, instead of a military force funded by every country in the world, Firaxis has made the game's early limitations make much more sense. As your new mobile base treks across the globe, places of interest are revealed to you. You'll need to scan an area for a number of days to uncover what's there, the equivalent of spinning the globe in the first game.

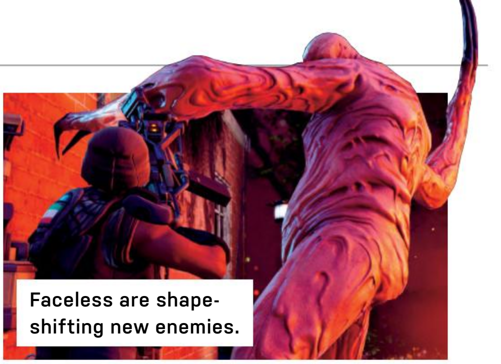
Waiting at resistance HQ will provide a bonus—such as faster building of base components or healing of wounded troops—but doing this means you're not scanning a region. Even relatively early in the game, you're forced to manage time carefully, because the only way to gain valuable supplies, important intel, or ready-promoted soldiers is to scan for it. As death is now to be expected when you go up against the alien menace, a supply of new recruits is essential.

Missions, many of them with a turn limit, come at you to distract you from the scanning, and you can soon find yourself in a situation where you've researched all manner of interesting tech, but can't afford to take any of it into battle as you don't have enough resources, and your best troops are wounded. It's a fine line to walk, and taking a squad of rookies with basic gear into combat can be suicidal… unless you can pull off a flawless mission, and come home with a valuable new engineer and a bunch of newly promoted squaddies.

The pressure is relentless, never really leveling off like the first game could when you were equipped with powered armor and plasma weaponry. As you expand from your starting territory by contacting other resistance groups, the amount of resources available increases, and chances arise to counter the Dark Events—the aliens' plans for humanity. These help make the game


Operation First Sword
OBJECTIVES:
Hack the Workstation on ADVENT Train
DIFFICULTY:
Easy
REWARDS:
101 Intel
Assault Rifle
PRIMARY WEAPON
Sniper Rifle
Increase Squad Size through the G.T.S facility.
CORPORAL
MORENO
SQUADDIE
CLARK
HALVORSEN
WARD
MAKE UTILITY ITEMS AVAILABLE
MAKE ARMOR AVAILABLE
BUILD ITEMS
LAUNCH MISSION

You'll eventually field six troops on missions.



Faceless are shape-shifting new enemies.

Sectoids are keen to use their psychic powers.

ADVENT OFFICER
FIRE WEAPON
Fire Weapon
Fire a shot at a target.
59%
0%
Elin Halvorsen

You should keep in cover to avoid enemy fire.

ADVENT troops look human, but have yellow blood.

feel less linear, even though you know you're on a path to something bad—mainly because of the glowering red countdown at the top of the screen.

SQUAD MIRE

Taking on any mission means selecting a squad, and there have been a few changes. The Sharpshooter is a sniper, but also good with a pistol—a weapon we used a lot more than in the first game. Assault troops have become Rangers, whose sword attack can be worth the risk of leaving them exposed. Specialists' drones can injure, hack, or heal, while the Heavy has become the Grenadier and switched rockets for a grenade launcher. Each class has two distinct upgrade paths, so having two Rangers in your squad needn't feel like doubling up.

Additional abilities can be unlocked using base components such as the Proving Ground. Skills that were perhaps underused—such as the pistols, or explosives' armor-shredding abilities—have been made more integral, while Overwatch, the ability to save action points for a reaction shot at enemy movement, is now utterly central, thanks to the addition of concealment.

Many missions start with your squad avoiding enemy lines of sight, moving around stealthily as you set up the most glorious of ambushes. Silently encircling a group of aliens, setting Overwatch, then using a grenade or sniper shot to announce yourself leads to kill after kill if you get it right. But you don't get a second chance, and a failed hack, or a grunt putting his foot the wrong side of a fence, will ruin everything.

Cover and flanking remain the core of the turn-based combat. Wounded soldiers take time to heal, and as you're scraping together enough resources to keep fighting, keeping them on active duty is important.

Every soldier is once again customizable, and further upgrades can be seen from the Unreal Engine, which delivers a game that's sharp where it matters, and soft where it needs to be—such as the edges of the tiles that make up the newly randomized levels. The game is fully moddable, with several available at launch, including one from seasoned vets Long War Studios. We did, however, experience camera problems, animations playing out of order and times when the game seemed unable to recover from an autosave pause.

XCOM 2 is a perfect example of a studio learning from its previous releases. Everything has been re-thought, improved, and put back with care. By stacking the odds against you like this, every downed Berserker becomes a significant victory, and every successful mission makes you a hero. **–IAN EVENDEN**

VERDICT
9
KICK ASS!

XCOM 2

+ ALIENS The game of 2012 made better; compelling strategy and combat.

− ALIEN 4 Made us feel weak in the face of its unrelenting pressure.

RECOMMENDED SPECS 3GHz quad-core CPU; 2GB ATI Radeon HD 7970, 2GB Nvidia GeForce GTX 770, or better; 8GB RAM.

$60, http://xcom.com, ESRB: T

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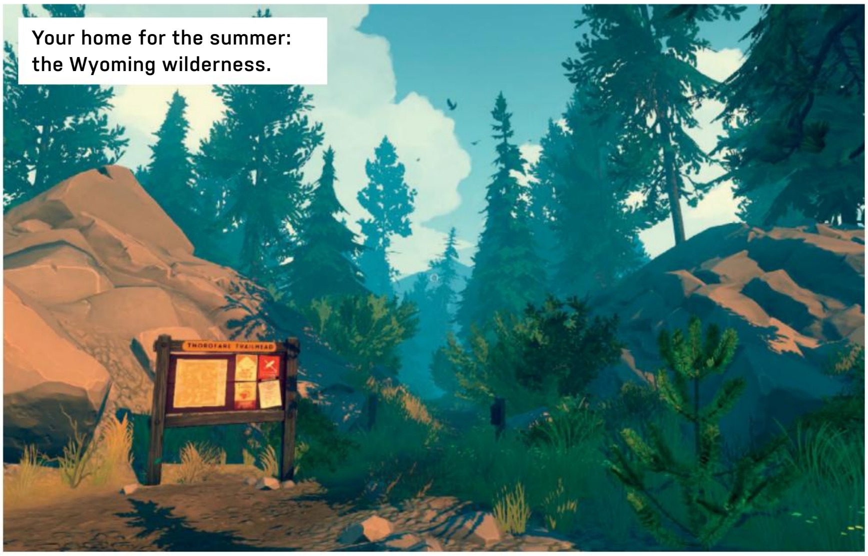
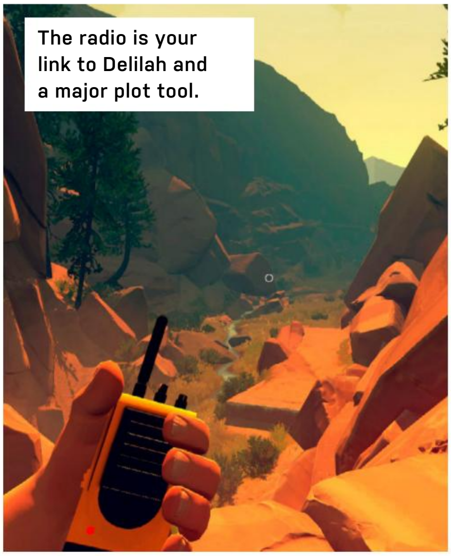
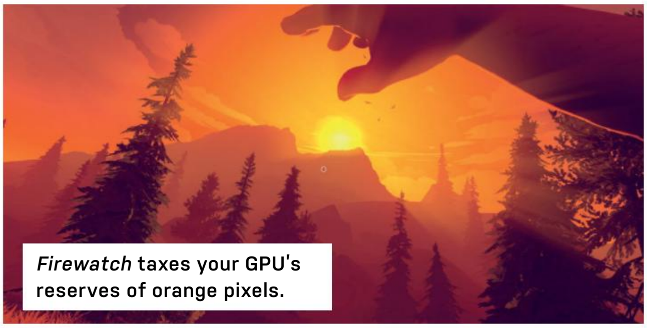


Your home for the summer: the Wyoming wilderness.



The radio is your link to Delilah and a major plot tool.



Firewatch taxes your GPU's reserves of orange pixels.

Probably the main reason for the game's M rating.

Firewatch

If a tree catches light in a forest with only you to witness it, do you make a sound?

THE GREAT OUTDOORS can be a creepy place. *Firewatch* is a small game set in a big forest in the 1980s; a place where it's almost always sunset, and where sad, bearded Henry—that's you—has come to man a fire lookout tower, and find the solitude he craves. He ends up having an adventure, in first-person, while wearing shorts.

Things start to get complicated, as is often the case, when other people intrude upon his loneliness. First up is Delilah, Henry's boss, and a warm, friendly, curious, perhaps even flirtatious, voice on the other end of a radio link. She gives Henry things to do that involve him hiking to a point in the forest, guiding himself using his map and, later, your memory of the trails. Something he finds along the way generally sets up the next "mission," or asks a question to which he'll need to find an answer. It's a simple structure but an effective one, the superlative voice-acting restoring any verisimilitude that the stylized, though beautiful, visuals may take away.

This style of game is often written off as a "walking simulator," but to label *Firewatch* with this epithet is to overlook both its ambition and its run button. A play-through will come in at six or seven hours, depending on how long you spend looking at the scenery or playing with the camera you'll find after a short time.

FIRE WATCH WITH ME

The game leads you through its story, often skipping long periods of time while Henry presumably dozes in his tower or does a crossword, but is at heart a character piece. The interaction with Delilah seems very real, and you feel as though the developers have been everywhere before you, thinking through every interaction, be it examining a pine cone or throwing a stereo in a lake, and know every route you'll take—making you walk back to your tower just so you can discover something, and warping you there when there's nothing to find. The downside of this is that the game's first act can feel like deliberate foreshadowing of the mysteries you'll uncover in the second half.

With no rushing, no stealth, and only a little bit of clambering around, *Firewatch* feels like the antithesis of modern gaming. It's a game for which exploration and communication are key, which asks you to empathize as much as improvise. And if that doesn't make you feel something, what's wrong with you? **–IAN EVENDEN**

VERDICT **8**

Firewatch

TIMBER Great looks; exemplary voice-acting; fine characters.

WHIMPER Slow pace; lack of freedom to really explore.

RECOMMENDED SPECS Intel Core i3 2GHz or AMD equivalent; 6GB RAM; Nvidia GeForce 450 or AMD equivalent with 1GB VRAM.

$20, www.firewatchgame.com, ESRB: M

LAB NOTES

ALEX CAMPBELL, ASSOCIATE EDITOR

Wireless Wins and Woes

Linux and wireless don't always get along

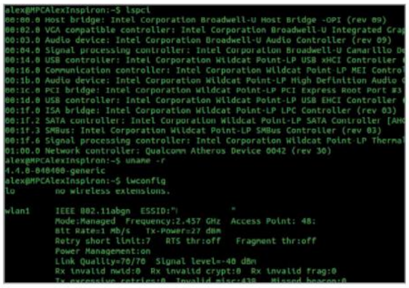
IF THERE'S ONE THING Windows users love to rag on Linux about, it's the finicky nature of its Wi-Fi drivers. Of course, in all the times I've installed Windows 8.1 or 10 on a test machine, not a single networking driver was ever autoloaded. But that's beside the point. Without networking, a Linux machine can feel like it's trying to run a marathon with one leg. It's a shadow of what it could be.

This was the case when I installed Ubuntu GNOME 14.04 on a Dell Inspiron 13 7000 Series notebook for a story I was working on. The built-in Qualcomm Atheros Wi-Fi card didn't work by default, so I used a Rosewill USB dongle I keep for emergencies.

When I finally revisited the laptop, I decided to look and see if there was support for the Wi-Fi in a newer kernel. Sure enough, the ath10k driver added support for this particular card around 4.2. That's a problem, since Ubuntu 14.04 sticks with the 3.6 kernel line. To get it working, I had to grab the kernel 4.4 deb packages (linux-headers-all, linux-headers-generic-amd64, and linux-image-generic-amd64) from Ubuntu's repo (http://kernel.ubuntu.com/~kernel-ppa/mainline/v4.4-wily) and install them. But here's the thing: Even after installing the newest kernel, you still need the firmware for your particular card. To do that, you have to get the firmware from kernel.org (https://wireless.wiki.kernel.org/en/users/Drivers/ath10k/firmware) or from Kalle Valo's GitHub (https://github.com/kvalo/ath10k-firmware). Once you have the firmware file, just copy it over to /lib/firmware/[device model]/hw2.0/firmware-2.bin. Restart your system, and voilà.

While you can install the newer ath10k driver by using backports, it requires you to re-compile the driver with every kernel upgrade. It's not hard, but it's easy to forget.

While I've got 802.11ac working on the Dell, my hope for support for my Yoga 2 Pro in the ideapad-laptop driver decreases by the day. Power management for the Wi-Fi card on that is still a thing of mystery to me.



```
alex@MPCAlexInspiron:~$ lspci
00:00.0 Host bridge: Intel Corporation Broadwell-U Host Bridge -OPI (rev 09)
00:02.0 VGA compatible controller: Intel Corporation Broadwell-U Integrated Grap
00:03.0 Audio device: Intel Corporation Broadwell-U Audio Controller (rev 09)
00:04.0 Signal processing controller: Intel Corporation Broadwell-U Camarillo De
00:14.0 USB controller: Intel Corporation Wildcat Point-LP USB xHCI Controller (
00:16.0 Communication controller: Intel Corporation Wildcat Point-LP MEI Contro
00:1b.0 Audio device: Intel Corporation Wildcat Point-LP High Definition Audio (
00:1c.0 PCI bridge: Intel Corporation Wildcat Point-LP PCI Express Root Port #3
00:1d.0 USB controller: Intel Corporation Wildcat Point-LP USB EHCI Controller (
00:1f.0 ISA bridge: Intel Corporation Wildcat Point-LP LPC Controller (rev 03)
00:1f.2 SATA controller: Intel Corporation Wildcat Point-LP SATA Controller [AHC
00:1f.3 SMBus: Intel Corporation Wildcat Point-LP SMBus Controller (rev 03)
00:1f.6 Signal processing controller: Intel Corporation Wildcat Point-LP Therma
01:00.0 Network controller: Qualcomm Atheros Device 0042 (rev 30)
alex@MPCAlexInspiron:~$ uname -r
4.4.0-040400-generic
alex@MPCAlexInspiron:~$ iwconfig
lo        no wireless extensions.

wlan1     IEEE 802.11abgn  ESSID:"                  "
          Mode:Managed  Frequency:2.457 GHz  Access Point: 48:
          Bit Rate=1 Mb/s   Tx-Power=27 dBm
          Retry short limit:7   RTS thr:off   Fragment thr:off
          Power Management:on
          Link Quality=70/70  Signal level=-40 dBm
          Rx invalid nwid:0  Rx invalid crypt:0  Rx invalid frag:0
```

Good things come in updated kernels.

JARRED WALTON

Senior Editor

DX12 offers game developers a new level of access to hardware. One option is Explicit Multi-Adapter mode, which allows heterogeneous graphics solutions. The latest *Ashes of the Singularity* beta simultaneously harnesses the power of AMD and Nvidia GPUs, rendering the game faster… usually. The cards need to be similar in performance and features, or things go south. Supporting other configurations would mean even more work. I wonder how many users have similar GPUs from AMD and Nvidia, and given they often have SLI/CF issues at launch, do we really expect game developers to do better? That it works at all is a cool "first," but widespread support seems unlikely.

ALAN DEXTER

Executive Editor

We're always testing here at *Maximum PC*. We test for reviews and roundups, but we also test to have hard numbers to go with everything we do. I recently ran the SteamVR performance test on one of my test machines, only to discover that the Radeon HD 7950 it housed wasn't really VR-capable (scoring 1.6 in the test). Given the surplus of gear in the office, it wouldn't be outrageous to think that my next move should be to reach for something newer to replace it. What I actually did was run every benchmark I had access to, so that I had those hard numbers to compare against when I did then slot an R9 390 in its place. There's nothing like numbers to keep a man happy.

Editors' Picks:
Digital Discoveries

Jimmy Thang, online managing editor, and Zak Storey, staff writer, discuss their latest finds

YOUTUBE RED

Netflix is one of those monthly paid services wherein the quality of entertainment you get outstrips what it costs. I think YouTube Red is right behind it. Specifically, I suggest you purchase the YouTube Red family plan, which allows you to share the account with five other family members and friends. A single YouTube Red subscription will cost you 10 bucks a month; the family plan only costs five dollars more.

What does YouTube Red do, exactly? Well, for starters, it gets rid of ads for everybody. You already use an ad blocker, you say? Well, it also removes YouTube ads on mobile, which is super nice. And when I say no ads, I mean NO ADS. No little pop-ups or the little skip-button ads. Google is also working with popular YouTubers like PewDiePie and such to make exclusive content just for YouTube Red, if you're into that sort of thing. But perhaps more importantly, YouTube Red also gives you and your family members access to Google Play Music, which offers around 35 million songs. Again, you won't be inundated with ads here either, and will be able to skip and rewind as you please.

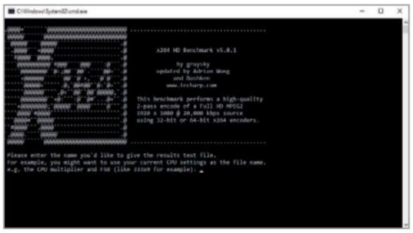
If you're broke and don't want to spend that much cashola, you can find some friends and family members to split up the $15 monthly fee, and each get it for $3 a month. Not so bad, huh?

YouTube Red

TECH ARP'S X264 BENCHMARK

When setting up any review, you have to look at the benchmarks you want to use. After all, you can write a 3,000-word masterpiece on a CPU, but if you have no quantitative data to back up your argument, it's as worthwhile as sending a ticket to Steam's customer support team. For motherboards, generally we're always looking for consistency. Usually, processor performance is the key winner here, because although overall overclock potential may vary from board to board ever so slightly, at the same frequencies, all motherboards should perform roughly the same.

One of my favorite benchmarks for mobo testing is Tech ARP's x264 v5.0.1 test. In short, it takes four separate MP4 video files and re-encodes them over to the x264 file format, timing how long it takes for that to happen, and how many frames the CPU renders each second, thus providing us with an fps result. The problem this month was down to the Tech ARP team migrating its website over to a new server, while accidentally corrupting the original x264 v5.0.1 benchmark. Fortunately for us, with a quick tweet sent out, the boys over at Tech ARP quickly had us up and running again, without which we wouldn't be able to bring you our group test today. Cheers, Tech ARP!



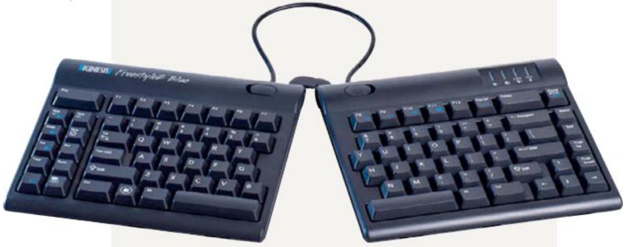
```
x264 HD Benchmark v5.0.1

by graysky
updated by Adrian Wong
www.techarp.com

This benchmark performs a high-quality
2-pass encode of a full HD MPEG2
1920 x 1080 @ 20,000 kbps source
using 32-bit or 64-bit x264 encoders.

Please enter the name you'd like to give the results text file.
For example, you might want to use your current CPU settings as the file name,
e.g. the CPU multiplier and FSB (like 33x9 for example):
```

GEEK TESTED & APPROVED



Kinesis Freestyle2 Blue

THERE ARE NICHE DEVICES, and then there's the Freestyle2 Blue. Do you want a wireless Bluetooth keyboard that supports up to three devices via Bluetooth multichannel technology? Great! But do you want a split ergonomic keyboard? That's a tougher sell.

Kinesis made its name building ergonomic keyboards, and the company is staying true to its roots. The Freestyle2 Blue does everything it's supposed to, and the ability to pair the keyboard with Android and iOS devices, as well as PCs, is particularly convenient. As someone who has used ergonomic keyboards off and on for the past decade, I appreciate everything Kinesis has done. But the target audience is tremendously small, and having two separate pieces can be less convenient to use and pack around—for example, it won't work on your lap. It's also rather costly, starting at $119 with a nine-inch cord. For the ultimate in ergonomics, you can add the Ascent accessory and mount the two halves vertically, but it more than doubles the price.

The Freestyle2 is expensive, but if you need an ergonomic Bluetooth keyboard, your options are pretty limited—as in, there's only one real choice, and this is it. While no conclusive evidence exists to prove that ergonomic keyboards will actually prevent RSI or carpal tunnel syndrome, I do find them more comfortable for lengthy typing sessions. This is one of the best truly ergonomic keyboard offerings, from a leader in the field. Just don't expect it to make you a faster typist. **–JW**

$119, www.kinesis-ergo.com

LETTERS

WE TACKLE TOUGH READER QUESTIONS ON...

> SSD Form Factors
> Triple-Screen Gaming
> Internet Saves

Pump Up My Storage!

Is there any way we can get drive manufacturers to think outside the (2.5-inch) box? Twenty years ago, HDDs came in two flavors: 3.5-inch for desktops and 2.5-inch for laptops. Five years ago, when SSDs started to become popular, it was still pretty much 3.5-inch for desktops and 2.5-inch for laptops. Even laptop HDDs barely hit 1TB, but a desktop was 2TB going on 3. My desktop case has two 2.5-inch slots and six 3.5-inch, so to install more than two SSDs, I must use an adapter.

Why can't the drive manufacturers make an SSD in the 3.5-inch form factor? It would fit three or even four times the memory. Instead of shrinking components to fit more inside a smaller box, why not use a bigger box? Why do we only get 2.5-inch SSDs? I would love a 4TB SSD in a 3.5-inch form factor. Then I can get rid of all my 1TB SSDs connected to five ports.

–Kurt Samuels

SENIOR EDITOR JARRED WALTON RESPONDS: Good question. It sounds like an awesome idea, right? If we can fit 2TB of flash memory into a 2.5-inch form factor, we could have tons more (at least 8TB, probably 16TB) in a 3.5-inch SSD! There's a few hurdles, however, and ultimately it comes down to economies of scale.

The number of users buying larger SSDs that can't fit into a 2.5-inch form factor is extremely small, mostly because we have 2TB drives already, and even though they're awesome, they're $600 or more. Making the drives larger wouldn't reduce the primary contributor to the higher price, which is all the NAND chips, so an 8TB 3.5-inch SSD would cost at least four times as much as a 2TB 2.5-inch model. I would love to test an 8TB drive, but if it costs $2,500, it's so far out of consideration for most users, that a manufacturer might be looking at selling only thousands if not hundreds of units. Unless they make it an enterprise product (see below).

So, we end up back at 2.5-inch drives, and the advantage of being smaller is that they can be used in both desktops and laptops. With roughly half of all PCs now being laptops, you don't want to potentially eliminate 50 percent of the market. In fact, we're going even further down the mobile route with things such as M.2, which allows for smaller drives (and lower capacities) while increasing performance. Since it's easy to make an adapter that enables you to use a smaller drive in a larger bay, manufacturing all SSDs at one size helps with production costs—and you don't need to estimate how many 2.5-inch drives you'll sell versus 3.5-inch drives.

And 2TB isn't even the limit for 2.5-inch SSD capacities. Manufacturers

[NOW ONLINE]

DEVELOPERS ON VR INPUT

Modern virtual reality headsets have been doing a good job of figuring out the visual equation for VR, but solving the VR input question is a much tougher nut to crack. How do you get your hands, feet, and body into virtual space? We had the chance to ask developers at Valve's SteamVR Developer Showcase what they thought of the Vive's and Rift's accurate tracked VR controllers. We also asked if they are concerned that the Rift will initially be shipping with an untracked Xbox controller, instead of the company's tracked Oculus Touch controllers. We got feedback on what type of controller devs would like to see, too, and some predictions on what VR input will look like in the near future. For the in-depth Q&A, check out our online story. http://bit.ly/MPC_VRinput

↘ submit your questions to: comments@maximumpc.com can do 1TB on an M.2 form factor if they want, and we'll likely see 2TB on M.2 drives by the end of this year. On the enterprise side of things, we already have 4TB class 2.5-inch drives (priced at roughly $2,000 for 2TB). The only thing holding back the creation of even higher capacity 2.5-inch SSDs is the associated costs and niche status. Samsung has already demonstrated 16TB 2.5-inch drives, which are slated to launch for enterprise customers this year. Granted, that's an oversized 2.5-inch drive, with a substantially thicker chassis (two 2.5-inch drives thick), so it's a bit like the 3.5-inch SSD idea. And OCZ did make its 3.5-inch Colossus 1TB drive back in the day (which is now a dinosaur by today's performance metrics); apparently, it wasn't successful enough to continue the line. But I, for one, look forward to the day when 4TB SSDs reach mainstream prices.

Three's Company

Thank you for an excellent publication, the information is invaluable to a gamer like me. But it seems that you are silent on triple-screen/surround/Eyefinity gaming. When reviewing monitors, it seems that nothing is mentioned for a triple-gaming setup, and I don't see published builds cover a triple-screen gaming rig.

–Adam Guarino

SENIOR EDITOR JARRED WALTON RESPONDS: Hi, Adam. Triple-screen gaming (and even dual-screen to a lesser extent) is mostly a niche market, so we don't routinely test with three monitors. Part of the issue is finding three appropriate monitors for use in testing, and then we need to have the space to set up all of them. That's easier said than done.

In practice, for gaming I would most strongly recommend going with identical monitors, for aesthetic as well as practical purposes. You should also look for screens where the left and right bezels are as thin as possible (the Asus MX27AQ and Acer XG270HU are two good options, though both are also 1440p—see below). Finally, you might want to find displays that support VESA stands, because that can help orient things nicely.

If you're mostly interested in benchmarks of surround gaming resolutions, I can provide a bit more help there. The short answer is that pushing pixels to three 1080p displays is slightly less demanding than running games at 4K; basically, performance should fall roughly halfway between our 1440p and our 4K results (assuming all the settings are the same). If you're thinking about using three 1440p displays in surround, however, the demands are very substantial—it's 33 percent more pixels than a 3840x2160 display, which means you'll need multiple high-end GPUs in many games to even have a chance of running with acceptable frame rates.

Once you have the necessary screens and sufficient graphics hardware to push pixels to them, you still need to configure your games to work properly. Some titles include native support, others will require Registry or INI file hacks, and some won't really work properly at all.

All of this explains why multi-screen gaming is such a niche market. If you're serious about putting together a surround gaming rig, and have the necessary space, when everything comes together properly, surround gaming can be a very cool and immersive experience.

Sketchy Saves

I don't know why Jimmy Thang would recommend an external service for "saving" web pages (and data mining you), when you can save them locally by printing to PDF. That's a built-in feature new to Windows 10, though it's been in Linux for ages.

–Ron Rogers Jr.

ONLINE MANAGING EDITOR JIMMY THANG RESPONDS: Hi, Ron. I'm not too concerned about the data mining issue—if I were, I'd stay off Facebook and Google. But I respect your decision to try to stay private. And to each his own, of course.

While it's true that you can save web stories as PDFs locally, Pocket works across all your devices simultaneously. So if you wanted to read an article on your phone that you had saved while using your desktop earlier, you could easily find it there through your Pocket folder. Another of Pocket's nice features is the ease with which you can share articles, images, and GIFs with friends through links. A little harder to do with a PDF that's saved to your desktop. Pocket also saves videos to your folder, which is something you can't do through PDF.

At the end of the day, how we use the Internet is a personal choice we all must make.

Facebook Polls

What's the better deal: Oculus Rift for $600 or the HTC Vive for $800?

Jared Kruse: The Vive can do more. Plus you get motion controllers from the start. Even if you don't have space for room scale, you can still do standing/sitting VR games on day one with the Vive motion controllers.

Joel Funaki Gonzalez: The Vive costs as much as a budget gaming PC. LOL!

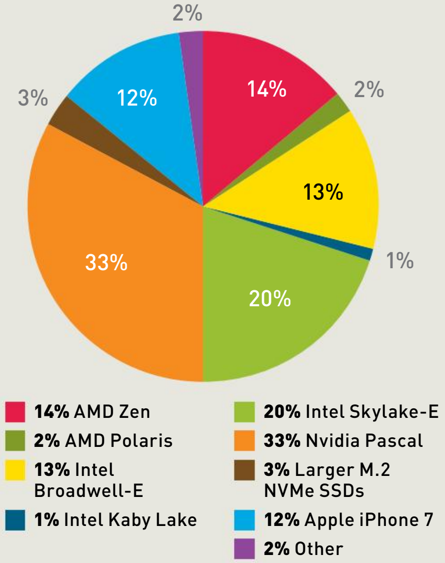
Gregg Hollings: I like the fact that the Rift is $200 cheaper. This won't force me into buying the Oculus Touch controllers when they release later this year, but I'll still have the option to upgrade. Plus, the Rift seems to be lighter and more ergonomic, and comes with an integrated audio solution, which the Vive does not offer.

Tyler Perillo: Oculus Rift, because first-gen tech always sucks, and when it does, at least you still have $200 in your pocket.

Michael Greenberg: After hearing the price of the Rift, I was worried that the Vive was going to cost $1,000 or more, so color me surprised to hear that it was just $800. I think the price is fair considering you're getting two Light Houses, two tracked VR controllers, and a front-facing camera all for just $200 more.

Adam Johnston: I'd rather spend the money and get the better controllers. Plus, it seems like the Vive will eventually have more games and be more fun.

What hardware are you most looking forward to?



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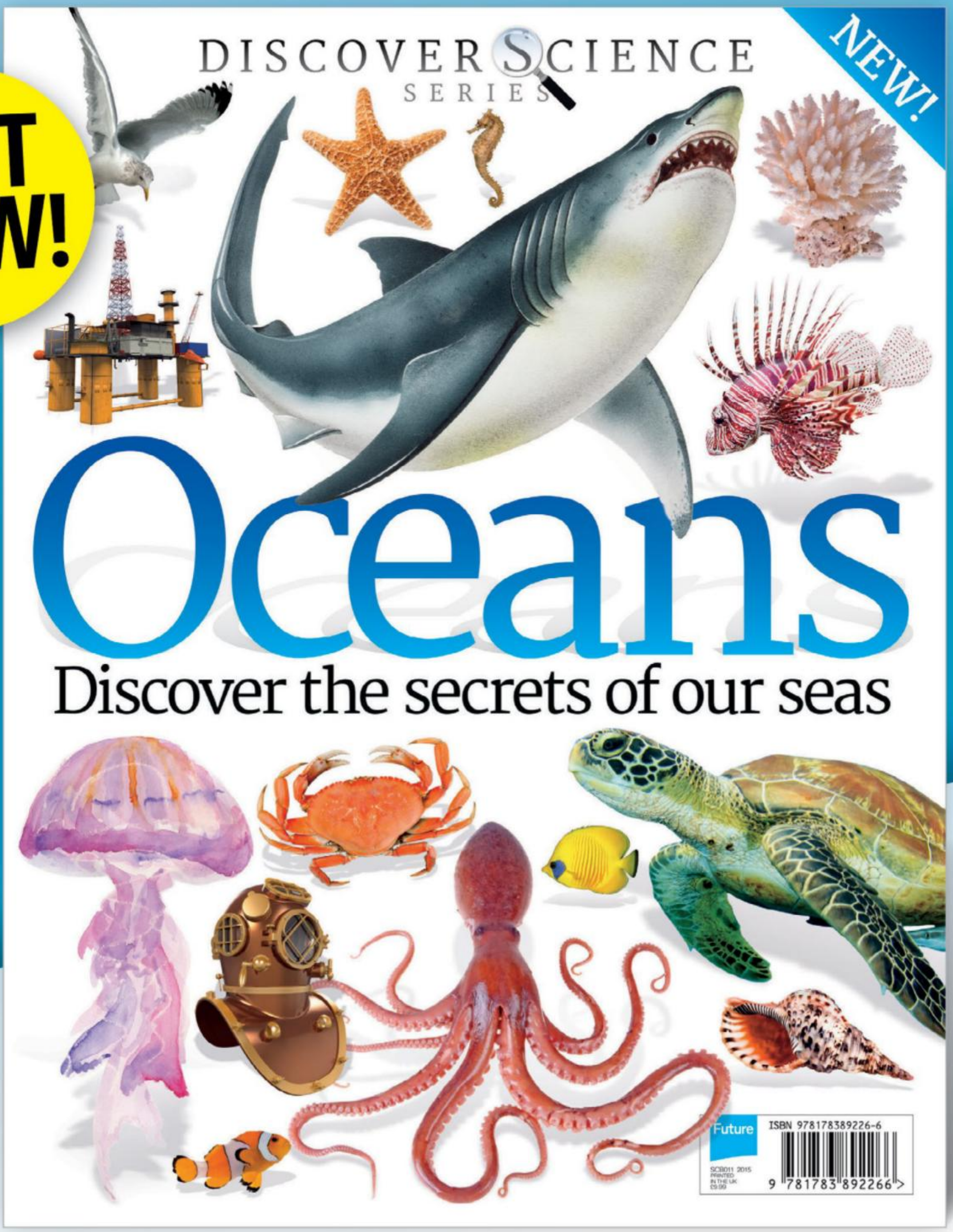

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THE BUILDS

BUDGET GAMER

INGREDIENTS

PART		PRICE
Case	Cooler Master Elite 110	$40
PSU	Corsair CS450M 450W/80 Plus Gold	$75
Mobo	Gigabyte GA-H170N-WIFI	$115
CPU	Intel Core i5-6500 **NEW**	$205
GPU	EVGA 1962-KR GeForce GTX 960 SC	$210
RAM	8GB (2x 4GB) Kingston HyperX Fury DDR4 2133 **NEW**	$41
SSD	8,250GB Samsung 850 EVO M.2	$94
OS	Ubuntu Desktop Linux 16.04 LTS 64-Bit **NEW**	$16

Approximate Price: $796

PRICES FLUCTUATED UP AND DOWN as they tend to, but we only really made one big change to the Budget Gamer this month. We chose to upgrade from the Core i5-6400 to the i5-6500. Besides just being a higher product number, the i5-6500 offers a jump in clock speed for about $15 more. That 15 bucks isn't much in the world of CPUs, so we feel comfortable making the jump, even if it were going to put the total cost of the system a little over $800 (which it didn't).

The other change we made was to the RAM. If you're looking for 8GB of DDR4 at 2,133MHz, prices all tend to fall into the same bracket. You can nitpick about timings all you want, but they tend to stay in the same range here as well. This Kingston kit has timings of 14-14-14, and that's pretty darn good. Other kits' timings aren't significantly worse, though. As long as you find memory that's the right price, and the right color and style for your build, you'll be OK.

MIDRANGE

INGREDIENTS

PART		PRICE
Case	Phanteks Enthoo Pro M	$70
PSU	EVGA SuperNOVA G2 650W	$103
Mobo	Gigabyte GA-Z170MX-Gaming 5 **NEW**	$140
CPU	Intel Core i5-6600K	$250
Cooler	Corsair H80i v2 **NEW**	$90
GPU	Asus R9 390 Strix 8GB	$330
RAM	16GB (4x 4GB) Corsair Vengeance LPX DDR4 2400 **NEW**	$84
SSD	500GB Samsung 850 EVO M.2	$160
HDD	Western Digital Black Series 2TB 7,200rpm	$127
OS	Windows 10 (*Download*)	$110

Approximate Price: $1,464

PRICES STAYED MOSTLY THE SAME for the Midrange, so we found it interesting to try to change things up. We ended up changing the mobo again, favoring the Gigabyte GA-Z170MX-Gaming 5. We used this micro-ATX board in our Winter Midrange build for the web, and we're quite happy with it. The Gigabyte is also $40 cheaper than the MSI board we used last month, so the budget-conscious can stay happy.

The other thing that helped keep the price below $1,500 was a price drop for the i5-6600K. Nabbing K-model Skylake chips has been tricky since the architecture's launch, and while most CPU prices stay relatively stable, the new Skylake chips don't seem to have settled yet.

The H80i v2 is just a newer iteration of the H80 we've been using for a while. The H80i offers cooling that's competitive with 240mm coolers with a different footprint. While the H80i isn't as long, the push-pull fan configuration makes the cooler quite tall.

TURBO

LAST MONTH WE WERE WELL BELOW THE BUDGET target of $3,000 for the Turbo, and this month we took it even lower. And we did it all without sacrificing performance on any key components. What's not to like?

The first thing we did was switch up the case—$180 is a lot to pay for a case, and it doesn't necessarily add power. We replaced it with Cooler Master's MasterCase 5. We love its modularity, and its options for cooling.

Speaking of cooling, we changed up the cooler to use Corsair's new H100i v2. Like the H80i v2, the new H100i is pretty much an update to an old favorite. With the same dimensions as the H100i GTX, the H100i v2 fits easily into the front of the MasterCase.

We got this build even closer to our web Winter Turbo build by going with MSI's X99A SLI Plus ATX mobo. This rig's main goal is to do two-way SLI, so we don't feel as though an extended ATX board serves it. (The MasterCase 5 is a midtower anyway.) With the Core i7-5820K, this rig is actually limited to two-way SLI, with 24 of its 28 PCIe lanes taken up by the GeForce GTX 980 Tis. To upgrade to three-way SLI would require another GPU, plus an upgrade to the CPU, which would push this build closer to $4,000 overall.

For more of our component recommendations,
visit www.maximumpc.com/best-of-the-best

INGREDIENTS

PART			PRICE
Case	Cooler Master MasterCase 5	**NEW**	$109
PSU	EVGA SuperNOVA G2 1,000W		$165
Mobo	MSI X99A SLI Plus	**NEW**	$230
CPU	Intel Core i7-5820K		$385
Cooler	Corsair H100i v2	**NEW**	$115
GPU	2x PNY GTX 980Ti (*Reference*)		$1,280
RAM	32GB (4x 8GB) Corsair Vengeance LPX DDR4 2666	**NEW**	$170
SSD	500GB Samsung 850 EVO M.2 (SATA)		$160
HDD	Western Digital Black Series 2TB 7,200rpm		$127
OS	Windows 10 (*Download*)		$110

Approximate Price: $2,851

UPGRADE OF THE MONTH

SAPPHIRE NITRO R9 380

If you're looking to spend around $200 for a graphics card, you have two (good) options: the GTX 960 and the R9 380. While we've built plenty of budget systems with the GTX 960, the R9 380 fights the good fight for Team Red in the budget category, and does quite well at doing the 1080p tango.

For a budget gamer looking to upgrade a basic PC to a gaming rig, this is a great GPU to consider.

$200, http://sapphiretech.com

MAXIMUM PC (ISSN 1522-4279) is published 13 times a year, monthly plus Holiday issue following December issue, by Future US, Inc., One Lombard Street, Suite 200, San Francisco, CA 94111. Phone: (650) 872-1642. Fax: (650) 872-2207. Website: www.futureus.com. Periodicals postage paid in San Bruno, CA, and at additional mailing offices. Newsstand distribution is handled by Curtis Circulation Company. Basic subscription rates: one year (12 issues) US: $19.95; Canada: US$24.95; Foreign: US$34.95. Canadian and foreign orders must be prepaid. Canadian price includes postage and GST (GST #R128220688). PMA #40612608. Subscriptions do not include newsstand specials. POSTMASTER: Send changes of address to Maximum PC, PO Box 5852, Harlan, IA 51593-1352. Standard Mail enclosure in the following editions: None. Ride-Along enclosure in the following editions: None. Returns: IMEX Global Solutions, PO Box 25542, London, ON N6C 6B2, Canada. Future US, Inc. also publishes @Gamer, Mac|Life, The Official Xbox Magazine, and PC Gamer.

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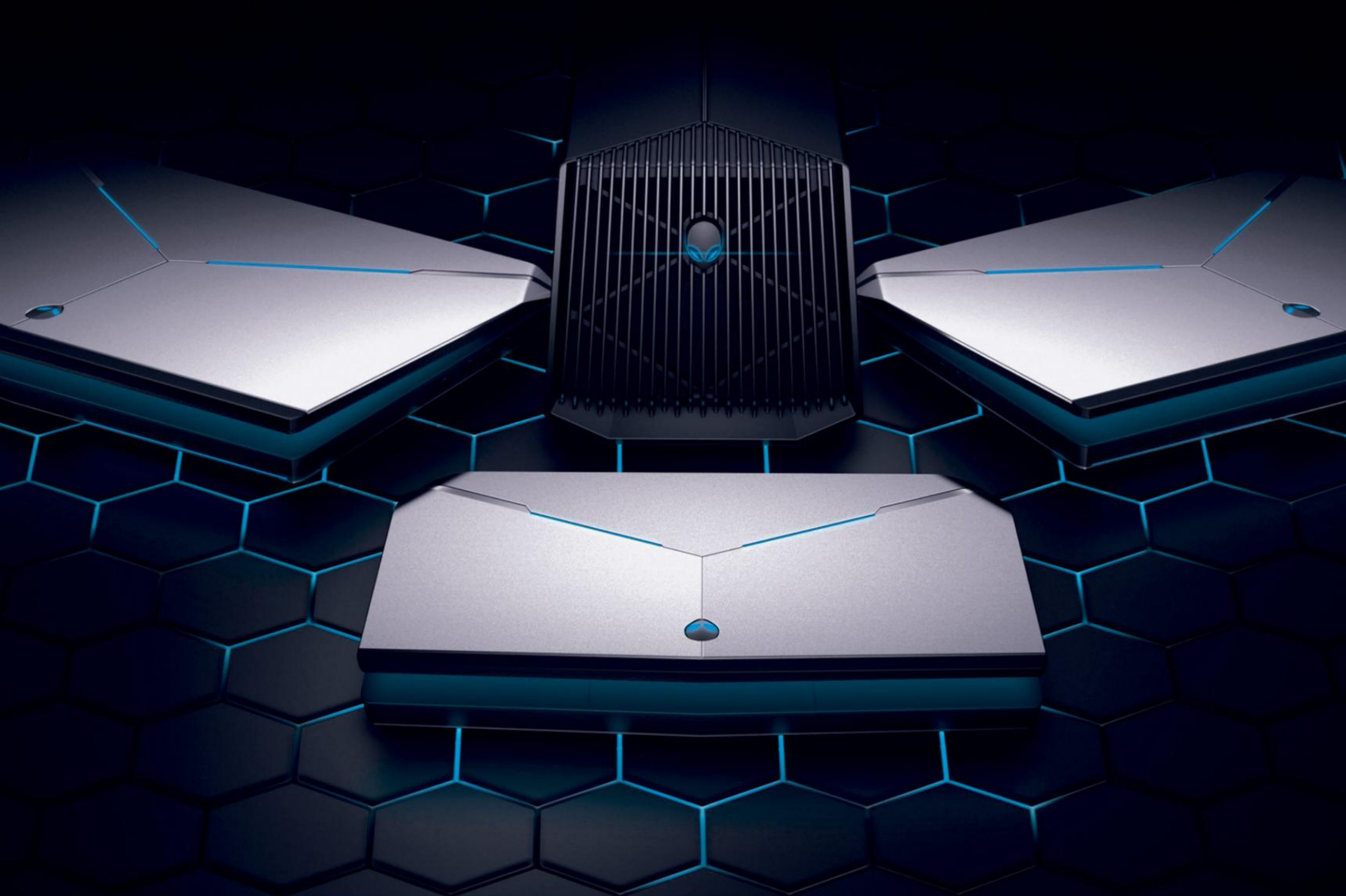

Alienware recommends Windows.

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